Roads and Streets

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The Greatest Defect in Engineering Education

The Society for the Promotion of Engineering Education has sent a questionnaire to all members of engineering societies and to the alumni of engineering colleges. The main object is to secure the consensus of opinion of engineers as to the best course of study to be pursued by men who aim to become engineers.

As we read the questionnaire we were impressed by the absence of any question that would disclose the belief that the training of habits is more important than the conveying of information. It is our belief that the learning of scientific principles in school or college, however important, is of far less importance than acquiring the habit of searching for useful information.

That relatively few engineers acquire such a habit is pretty clearly indicated by the relatively small paid circulations of engineering magazines, the relatively small sale of engineering books, and the scant use of engineering libraries. Subscription solicitors report that the commonest reason assigned for unwillingness to subscribe is lack of time for reading. The next commonest excuse is: "I subscribe for one magazine already, and fail to see why I should take another." Such answers coming from graduate engineers means only one thing, we believe, namely a failure to have acquired the habit of diligently searching for usable information.

Edison has stated that he reads regularly more than 50 scientific magazines. His much discussed questions put to applicants for jobs indicate that he aims to see how diligent the applicant has been in searching for scientific information. If the answers show that the applicant has not been much of a reader of science, then Edison has no use for him. This test would cause him to reject the great majority of engineering students, because their time has been spent mainly in learning how to solve problems all the data for which have either been stated in the problem or in the text books or lectures. Such training is important, but surely it is equally important to train students to do in college what they must do in after life if they are to succeed greatly in their profession. In after life, the average problem can be solved properly only when adequate data have been secured by search or by experiment. But the average student has learned neither the importance of searching nor how to search to say nothing of having become so used to searching that he does it instinctively and thoroughly. Practically no students have acquired the habits of experimenting. Being neither searchers nor experimenters by habit, they are apt to remain mere adherents to the precedents with which they are best acquainted, which as Henry Ford has recently emphasized, are almost certain to be methods that can be, and frequently have already been, greatly improved.

We recall the case of an engineer who specialized in water works, and who did not know about the copper sulphate treatment of water to remove algae, although its successful use had been described in the civil engineering press time and again during many preceding years! He was spending his clients' money in the vain effort to remove the algae

by a crude process of filtration. Investigation disclosed that he had ceased subscribing to any civil engineering magazine, because he "didn't have time even to read all of the hydraulic papers published in the transactions of the American Society of Civil Engineers." Too busy to read, because he was so busy wasting his clients' money.

The Cry of Cities for Wider Roads

Many cities are complaining that not enough of the funds available for state highways are spent near the cities. This criticism is growing in volume, and it will command increasing attention. We reprint a recent editorial on this matter from *The Chicago Tribune*, which is very temperate in tone. The claim is made that Cook county, in which Chicago is located, has received an inadequate share of state highway money.

In the early days of road improvement it was doubtless proper to build relatively narrow roads, and to assign a large part of state highway funds to regions remote from the cities. The roads so built are largely responsible for the enormous increase in automobiles owned by city residents. The increase has become so great that traffic in and near many cities is extremely congested. So much so that sound economics calls for greatly increased expenditures of state and county highway funds near such cities until traffic congestion is relieved.

It would be very unfortunate were the large cities to oppose gasoline taxes and road bond issues because of resentment over what they regard as a hogging of road funds by the remote country districts. Yet such opposition is already beginning to find voice here and there.

New San Francisco Engineers Society

The San Francisco Society of Engineers is the name chosen for a newly organized body, comprising a membership of 500 engineers representing all branches of the profession. The object of the society is to bring about a co-operation among engineers and promote the social interests of its members, the majority of whom reside in the bay regions. The society maintains a secretary bureau and headquarter offices at 952 Pacific Building, San Francisco. Officers are, C. H. Tucker, president; Glen B. Ashcroft, vice-president; A. J. Capron, secretary; G. H. Geisler, treasurer. The directors are William H. Phelps, R. C. Briggs, C. T. Wiskocil, R. C. Hunt and L. L. Leurey, past-president.

Council Manager Plan at Kansas City, Mo.—The new council manager plan charter for Kansas City, Mo., which was adopted Feb. 24, 1925, by a vote of more than 4½ to 1 became effective on April 10th. A complete new administrative code providing for the details of transition to the new plan of organization has been prepared. H. F. McElroy, former judge of the county court and a prominent local real estate man is the first city manager.

Road and Street Contracts Awarded During the Last 75 Months

The accompanying table, compiled from statistics in the Engineering News Record, shows two outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923	1924	1925	1926
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000	$ 16,972,000	$ 22,720,000	$ 19,989,000
February	21,334,000	12,049,000	9,052,000	18,781,000	19,214,000	20,104,000	12,189,000
March	26,221,000	25,880,000	39,669,000	37,706,000	41,395,000	25,910,000	30,271,000
April	33,340,000	31,026,000	32,991,000	29,641,000	43,513,000	60,801,000	.....
May	30,258,000	35,064,000	42,284,000	46,528,000	65,354,000	53,418,000	.....
June	31,441,000	56,777,000	42,138,000	38,040,000	44,494,000	42,451,000	.....
July	29,353,000	33,943,000	26,087,000	42,397,000	45,784,000	45,246,000	.....
August	18,565,000	28,693,000	37,035,000	35,639,000	40,536,000	41,199,000	.....
September	26,537,000	23,257,000	28,884,000	37,812,000	44,585,000	36,949,000	.....
October	12,894,000	20,055,000	23,162,000	28,144,000	35,198,000	31,416,000	.....
November	12,443,000	20,751,000	20,892,000	23,683,000	18,382,000	23,492,000	.....
December	10,834,000	16,263,000	18,096,000	21,035,000	14,894,000	19,635,000	.....
Total	$265,424,000	$315,356,000	$334,741,000	$381,097,000	$430,231,000	$423,341,000	.....

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

The Method of Scientific Discovery

By HALBERT P. GILLETTE
Editor

Scientific reasoning differs from ordinary reasoning only in being more systematic and more thorough. Original thinking differs from ordinary thinking only in the degree of novelty of the result. All thinking is a memory process. Since memory is aroused by some likeness, it follows that original thinking must originate in the perception of a likeness.

A study of many scientific discoveries has failed to disclose any discovery that was not guided by the perception of a likeness or analogy. The wave theory of sound was suggested by certain likenesses between sound phenomena and waves in water. The wave theory of light, in turn, was suggested by analogies between sound and light phenomena.

If, as I believe, all original thinking is founded on perception of similarities, it follows that the most helpful guide to a new law or theory must be a resemblance between a poorly understood phenomenon and a well understood phenomenon. The latter then becomes the guide in exploring the former. But if the investigator uses as his guide a phenomenon that is itself poorly understood, he is almost certain to fail in his search. Let me illustrate by two examples.

An analogy with a well known phenomenon leads to an hypothesis which hypothesis announces a greater similarity. If this assumed greater similarity leads to a tentative generalization regarding the poorly known phenomenon, then inferences are made from this generalization, and the inferences are compared with the facts. If facts and inferences agree there is probability that the hypothesis is a correct theory. And when the agreements between fact and inference are shown to be wide in range and great in number, the probability that the hypothesis is correct grows greater, until it may reach that very high degree of probability that we call "certainty."

Too much emphasis can not be placed upon the wisdom of seeking a likeness between the poorly known phenomenon and some very well known phenomenon. The blind alleys up which the investigating mind most often wanders are usually likenesses between poorly known phenomena. The ancient devil-theory of disease is a case in point. Even less was known about devils than about diseases, so no progress in the knowledge of disease could come from a devil-theory of disease.

Let us take an example of an hypothesis based on an analogy with an ill known phenomenon and contrast it with an hypothesis based on a fairly well known phenomenon.

La Place knew that in our solar universe all the planets move in the same direction around the sun. By analogy, this suggested that they had been produced by a whirling mass of nebulous matter. As the nebulous matter contracted under the influence of gravitation, he conceived that parts of it were left behind and condensed into the planets. He attempted to explain one phenomenon in terms of another about which he was equally ignorant; for what did he know about the phenomenon of nebular condensation?

Suppose, on the contrary, we now look for some stellar phenomenon about which we have considerable knowledge, and one that today manifests an ability to produce planets. As the geologists seek to explain the origin of sedimentary rock by observing the deposition of mud in a river delta, or sand on a sea shore, so let us seek the cause of the planets in the present activities of the sun itself. The instant such a simple course suggests itself, our attention focuses upon the sun spots. Here are vast whirlpools from which emanates a force capable of elongating the tail of a comet millions of miles away, forcing its substance away from the sun, and therefore more powerful than the sun's gravitation. These vast whirlpools occur periodically. They wax and wane. When the sun was hotter than it now is, these sun spots were doubtless much larger in diameter and greater in depth. May they not have generated the planets by expulsion of material from the sun even as they now force the tails of comets away from the sun?

By analogy with a fairly well known phenomenon, we frame an hypothesis of stellar evolution or genesis. Now let us draw a few inferences from it and see whether they accord with the facts.

First, since the sun spots are cyclic, we infer that the planets were produced by periodic discharges of sun material. This periodicity of discharge, coupled with a waning energy of the sun, would lead us to expect to find the paths of outer planets farther separated than the paths of the inner planets. Moreover, we should expect to find a mathematical relation between the distances of the

planets from the sun. Investigation shows this to be the case.

Second, since there is a periodicity of sun spots, we infer that there is some sort of pendulistic action of the sun's core relative to its outer shell. If so, as the core approaches the surface on one side, there would occur a bursting forth of sun spots on that side; to be followed later by a bursting forth on the opposite side. Hence if stellar systems are now in the early stages of evolution, we should find nebular having spiral arms always in pairs, and the origin of those arms at opposite ends of a diameter of the nebular core. This is the case.

Third, if sun spots on other stars are waxing and waning, we should find rather sudden increases and decreases in brilliance of certain stars. This is the case.

Fourth, if the outermost planets were ejected first, we should expect them to have the lowest density. This is so.

Fifth, if the energy of the sun was waning during the genesis of the planets, we should expect to find the largest planets the farthest from the sun. This is so.

Sixth, since the planets themselves were suns, we should expect to find their moons arranged in mathematical series from the planet. This is so.

Seventh, if the moon was ejected by an earth vortex, or earth "spot," we should expect to find an area of great elevation, whence the moon material came; because the lateral inflow of lighter surface material to fill the cavity would produce an abnormally great protuberance. This is so.

Eighth, the reactive push of the material ejected from the earth to form the moon should have produced a great tilting of the earth's axis. This is so.

Ninth, the topography and stratigraphy of the earth's crust should show many geometric regularities traceable to the gensis of the moon. It does.

Known physical forces should suffice not only to account for the ejection of material from a sun spot, but to account for its not traveling to infinite distances. This is the case, for the pressure of light waves acting upon the surface of a sufficiently small particle is known to exceed the sun's gravitational pull. Then as the mutual gravitation of such small particles caused them to unite into larger particles, the gravitational pull would finally balance the radiant wave push; for the latter is a surface phenomenon and consequently varies as the square of the diameter of the body, whereas the former is a mass phenomenon that varies as the cube of the diameter where density is constant.

I have mentioned only a few of the inferences from the sun spot theory of star genesis. I have found that many others accord with the facts.

It is natural inference to suppose that if this sun spot hypothesis is true of our solar system it may be true of all heavenly systems. If we regard a sun spot as a rifle barrel discharging bullets, and if the barrel does not maintain a constant angle with the sun's surface, it follows that it will give to the bullets a tangential force that will vary, and that it may vary not only in intensity but in direction. Since it is this tangential force that determines the direction of revolution of the planet about the sun, it follows that a pendulistic motion of the gun barrel would cause some planets to revolve in one direction and some in the opposite direction. Now this is exactly what has occurred in some of the moons of planets.

It is one of the characteristics of a correct theory that it usually explains phenomena that it was not designed to explain. Thus, the sun spot theory of planet and star genesis throws great light on the phenomenon of geologic periods. When the earth was beginning to solidify, the sun spots were doubtless far more intense than now. Therefore they must have caused enormous periodic changes in climate, temperature, rainfall, etc., on the earth. Such changes obviously had profound effects not only upon erosion of the earth's crust but upon the living things that inhabited the earth. Our recent "ice ages" are probably of sun spot origin; but long before these recent "ice ages" there were much more pronounced cycles of low and high temperature. This explains the recurring catalycisms among plants and animals that left scarcely a wrack behind—the great geological periods.

Overproduction Is Predicted in Portland Cement Industry

So great were stocks of portland cement in the warehouses of manufacturers at the end of the first quarter of 1926, and so unfavorably did production and shipments compare with those for a similar period last year that the question has been raised in the minds of many authorities as to whether the cement industry has not expanded to the point where overproduction may become a chronic state.

Figures given out by the U. S. Bureau of Mines show that finished cement in storage at the end of March totaled 23,212,000 barrels while unground cement in the form of clinker equalled 12,277,000 barrels more, giving a total of 35,489,000 barrels. Cement stocks a year

ago were 20,469,000 barrels and clinker stocks 9,962,000 barrels, or 30,431,000 barrels in all.

During the first three months of this year the portland cement field produced 25,941,000 barrels. In the same period last year the production was 28,145,000 barrels. Shipments in January, February and March of this year totaled 20,991,000 barrels. For the same months last year they were 21,456,000 barrels.

The large stocks now on hand reflect the recent marked expansion in cement manufacturing facilities, which is continuing this year, and also a falling off in demand for cement from last year. Annual productive capacity at the beginning of 1926 was estimated at 190,000,000 barrels, and it is expected that mills and extensions under construction will bring this to the 200,000,000 mark this year. First quarter production was at about 55 per cent of present capacity.

Total shipments in 1925 were 156,724,000 barrels. Manufacturers are expressing doubt that demand this year will equal that figure, especially in view of the showing for the first quarter.

Wider Roads

Editorial in "Chicago Tribune."

Chicago is lagging behind other cities in the widening of the roads as they approach the city. Mr. Jenkins, *The Tribune's* automobile editor, reports that Detroit not only has established 40 feet as the standard width for all pavements on main roads leading into the city but has actually begun construction of some of them. Detroit is also building double track arteries, each forty feet wide, to accommodate the heaviest traffic.

Pennsylvania proposes to make the Lincoln highway 40 feet wide across the entire state. The New York Albany post road has been widened to permit three lanes of traffic. The added lane enables a machine to pass a slower moving vehicle going in the same direction without danger of being struck by a car coming in the opposite direction. There is only 50 per cent. more pavement than before but the carrying capacity of the road has been increased much more.

Through the country, only the fewest railroads require more than a double track. As the terminals are approached, the facilities have to be increased. The highway builders did not appreciate the terminal problem. They did not realize that the usefulness of the entire system of highways would be lessened if the terminals were clogged with traffic. The program for widening the roads into Chicago will cost only $12,000,000, it has been estimated.

Thousands of Chicagoans, to say nothing of downstate motorists, are not getting their money's worth from their automobiles because the $12,000,000 has not been spent. The millions of dollars that the state has invested in building its system of hard roads is not bringing its full return. Those are hard facts which the Good Roads committee of the Association of Commerce will consider at its meeting today, called to discuss ways and means to finance road widening in Cook county. The city looks to this committee to work out a plan and fire public officials with the zeal to carry it into effect.

The Massachusetts Highway Association Road Show

The Second Annual Open Air All New England Road Building Machinery and Materials Show will be held on the Charles River Parkway, Cambridge, at the Cottage Farm Bridge, Thursday, May 13, and Friday May 14, 1926, under the auspices of the Massachuetts Highway Association. It is expected this Show will by far eclipse the one day show of last year, and which had an attendance of over 5000. Over 90 exhibitors now have expressed a readiness to show their most modern road building machinery and highway construction materials. The committee has found it necessary to rearrange spacings so as to get the best possible results out of the 600,000 sq. ft. of land used for this exposition, at the same time to provide sufficient demonstration area so that all mobile machinery can be put into operation for demonstration purposes. Show will go on "Rain or Shine." On the evening of the opening day, the regular quarterly meeting, dinner and entertainment of the association will take place at the City Club, Boston, Mass., and a good time is assured to all attending. The Executive Committee in charge of the show, is as follows: Fred B. Richardson, President, Massachusetts Highway Association.; John M. McCarthy, Secretary, Massachuetts Highway Association; James O. Jordan, Jr., Hedge & Mattheis Co.; C. F. Reuter, Mead-Morrison Manufacturing Co.; B. F. Surrett, Dyar Sales & Machinery Co.

Research At Michigan State College.—The study by the Michigan State College of the Effect of Freezing Temperatures on Lumnite Cement Concrete is completed and the bulletin well be published soon. Another project under way at this institution is that on Bituminous Fillers for Cracks in Concrete Pavements which will probably be completed in June.

Highway Construction in Cuba

The Cuban Cabinet, at a special meeting held on April 12 to consider measures to be adopted in relief of the economic crisis through which business is now passing, decided to make every effort to initiate immediately the work of constructing the Central Highway. A special commission was appointed to investigate the situation. On April 14 it was announced that conditions for the bids would be drawn up immediately and that bids would be accepted for sections or all of the highway, provided the contractor's methods of financing did not conflict with Article X of the Public Works Law. Secretary of Public Works Cespedes drew up a statement for the President which was published April 15 and which furnished the first official and comprehensive statement on the question that has appeared for some time.

According to a speical circular of the Transportation Division of the Bureau of Foreign and Domestic Commerce of the U. S. Department of Commerce, Secretary of Public Works Cespedes outlined the situation as follows:

The Efficiency of the Taxes Created for the Special Public Works Fund.—He affirms that nine months' experience of the Government in collecting these taxes has demonstrated without doubt their potential efficiency. Estimates reached at the time the laws were passed have been verified in practice and the collection of the taxes has not offered any unforseen difficulty. He believes that the taxes are economically sound and that the people are not adverse to paying them, as they realize that the funds are to be devoted to active construction work throughout the island. The revenues will total, for the present fiscal year, an amount in excess of $11,000,000, and next year, together with the $5,000,000 special appropriation under the general budget and with a more efficient system of collection, will exceed $17,000,000. Mr. Cespedes adds that Cuban and foreign financial experts believe that total revenues over the ten years will reach $200,000,000.

Projected Works Under the Public Works Fund.—The Secretary points out that definite studies were not made of any of the projects to be carried out under the present administration and that, therefore, the work of his department has been enormous in preparing all this preliminary data. Of the 1,099 kilometers which will constitute the Central Highway, surveys have been completed by the Department of Public Works of over 900 kilometers which, according to Mr. Cespedes, will permit the government to draw up at once the conditions for letting contracts. As regards construction of the Santiago aqueduct, and the improvement of the Havana aqueduct, Mr. Cespedes states that basic studies have been made of both projects and that the location of the former has definitely been decided. The contract for this construction will be let by the government during the coming month of July. The Havana aqueduct is still under study. The Secretary calls attention to the fact that contracts have already been let for the Malecon sea-wall and the construction of the capitol building, both of which projects come under the Public Works program.

Application of Public Works Funds.—The general public works plan, according to Mr. Cespedes, was drawn up for completion within a period of four years. To carry out this idea, however, it would be necessary to apply the revenues over a period of ten years, or, in other words, to construct in four years and to pay in ten. He refers, in this connection, not to all of the projects contained in the public works plan, but to the principal and fundamental projects. Article X of the Public Works Law, however, specifically provides that the contract for construction works may not be entered into by the government if the yearly payments in return for such work cannot be made in whole each fiscal year, with the normal revenues estimated under the special fund, and it additionally forbids the issue of certificates of indebtedness or other similar documents. Mr. Cespedes mentions in few words the difficulties they have been up against in face of these provisions as regards the financing of the principal projects. The Secretary renews his desire to complete the principal projects, and mainly the construction of the Central Highway, in the shortest possible time, and says that he hopes within a period of 90 days assigned for letting the contracts, that a satisfactory resolution of the problem will be reached.

U. S. Good Roads Association Convention.—Santa Monica, Calif., is to be the scene of the United States Good Roads Association's 1926 National Convention, which will be held in conjunction with the Bankhead National Highway Association and the United States Good Roads Show, during the week of June 7th to 12th, 1926. J. A. Rountree, Miramar Hotel, Santa Monica, Calif., is director general.

Elements Affecting Concrete Construction

Chart Presentation of Various Factors Given California Highways

By C. S. POPE
Construction Engineer, California Highway Department

The following charts have been prepared for use of resident engineers and others with a view to predicting results which may be expected on different phases of concrete construction.

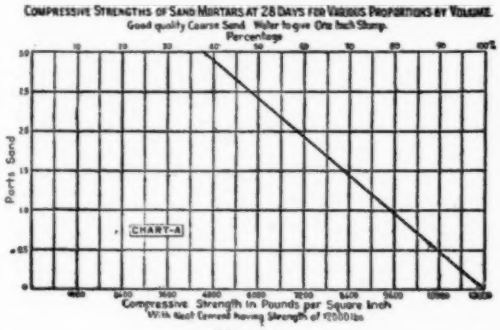

COMPRESSIVE STRENGTHS OF SAND MORTARS AT 28 DAYS FOR VARIOUS PROPORTIONS BY VOLUME.
Good quality Coarse Sand. Water to give One Inch Slump.
Percentage
Parts Sand
CHART-A
Compressive Strength in Pounds per Square Inch
With Neat Cement having Strength of 12000 lbs

Chart A

The data have been assembled from various sources which seem dependable but principal reliance has been placed on material available at this time from our own laboratory.

In common with all such generalizations, individual cases, due to the very numerous causes which may affect the results of tests of concrete materials may be expected from time to time to show results at considerable variance with the findings of these charts.

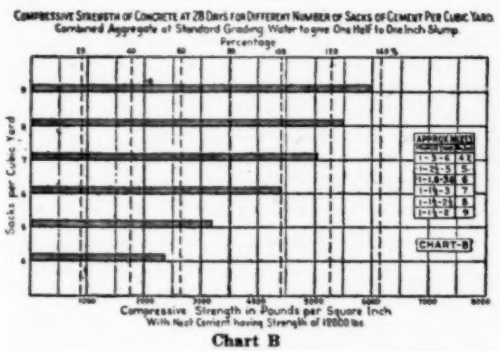

COMPRESSIVE STRENGTH OF CONCRETE AT 28 DAYS FOR DIFFERENT NUMBER OF SACKS OF CEMENT PER CUBIC YARD.
Combined Aggregate of Standard Grading. Water to give One Half to One Inch Slump.
Percentage
Sacks per Cubic Yard
APPROXIMATE MIX
CHART-B
Compressive Strength in Pounds per Square Inch
With Neat Cement having Strength of 12000 lbs

Chart B

Application of common sense and discrimination in their interpretation, however, will enable engineers to recognize the influence of these various factors and will make the charts of great value to those who have occasion to use them, and who properly interpret the data furnished by them.

Chart A.—This chart gives compressive strengths of sand and mortars of various proportions. The strengths are given in percentages of comprehensive strength of neat cement. A cement having a compressive strength, neat, of 12,000 lb. per square inch at 28 days is assumed as 100 per cent and all values given are prorated on the basis of the use of this cement in the varying proportions required.

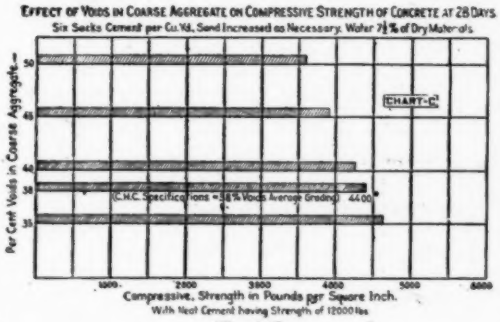

EFFECT OF VOIDS IN COARSE AGGREGATE ON COMPRESSIVE STRENGTH OF CONCRETE AT 28 DAYS.
Six Sacks Cement per Cu. Yd., Sand Increased as Necessary. Water 7½ % of Dry Materials.
Per Cent Voids in Coarse Aggregate
CHART-C
(C.H.C. Specifications = 38 % Voids Average Grading) 4400
Compressive Strength in Pounds per Square Inch.
With Neat Cement having Strength of 12000 lbs

Chart C

The strength ratio shown assumes a sand which is structurally sound. A sand which is structurally weak will show higher strength ratios with a cement having a low neat strength than with a cement having a high neat strength. The stronger cement brings out the weakness of the sand and the strength ratio for such a material would not be a straight line in the graph shown.

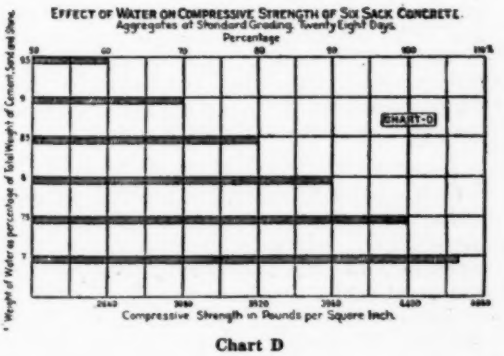

EFFECT OF WATER ON COMPRESSIVE STRENGTH OF SIX SACK CONCRETE.
Aggregates of Standard Grading. Twenty Eight Days.
Percentage
CHART-D
Compressive Strength in Pounds per Square Inch.

Chart D

Sixty per cent is probably a conservative figure to use in estimating the probable strength of field concrete based on mortar strengths, the ratio of sand to cement in both concrete and mortar being the same.

Chart B.—This chart shows compressive strength of concrete with varying cement con-

tent. The compressive strength is shown in pounds per square inch based on first-class aggregate, and cement testing neat at 12,000 lb. per square inch at 28 days. The concrete is assumed to have a ½-to-1-in. slump, the water varying slightly as required by its aggregate.

Chart C.—This chart shows the effect of voids in coarse aggregate on compressive strength. The graph is particularly valuable and is shown both in percentages and in pounds per square inch. The effect of excess voids in the coarse aggregate is, of course, to require the addition of more sand to maintain workability with a corresponding decrease in compressive strength of the concrete.

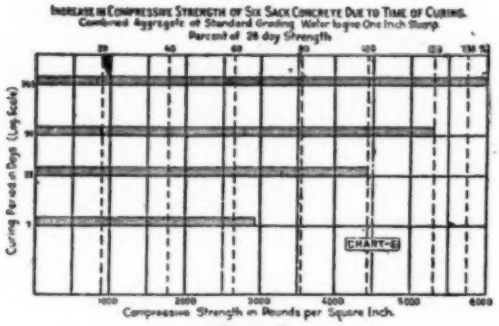

Increase in Compressive Strength of Six Sack Concrete Due to Time of Curing.
Curing Period in Days (Log Scale)
CHART-E
Compressive Strength in Pounds per Square Inch.

Chart E

Chart D.—This table shows effect of water on compressive strength and is founded on tests in our own laboratory, on tests in Bulletin No. 58 of the Bureau of Standards, and on tests by Prof. Abrams.

Chart E.—This chart shows increase in compressive strength with increased time of curing. The values shown will vary more with conditions than those given in other tables. In this instance the values are based on mean temperatures of 70 deg. or higher. Lower temperatures will retard curing time.

Civil Service Examination for Transitman—The U. S. Civil Service Commission, Washington, D. C., has announced open competitive examinations for transitman at $1,680 per year, and senior transitman at $1,860. The examinations are to fill vacancies in the Forest Service, Department of Agriculture, and vacancies in postions requiring similar qualifications.

New City Manager Cities.—Cities of over 100,000 population that adopted the city manager form of government at recent elections include, Forth Worth, Tex., Cincinnati, O., Kansas City, and Rochester, N. Y.

No Changes in Paving Brick Varieties

The standing Committee on Paving Brick Simplification, functioning with the U. S. Department of Commerce, held its annual meeting in Washington, April 1. As a result of its deliberations, no changes were made in the present list of four recognized varieties.

The survey of shipments in 1925 showed that a total shipment (representing 96 per cent. of the tonnage capacity of the industry) of 353,600,000 brick, 74.2 per cent. were in the four recognized varieties. Percentages for the individual sizes in 1924 and 1925 are shown in the accompany table.

Shipments of Recognized Varieties of Paving Brick in Per Cent of Total Shipments

	Per Cent. 1924	1925
Plain wire cut		
3 x4x8½ inches	43.1	40.7
3½x4x8½ inches	11.0	5.5
Repressed lug		
3½x4x8½ inches	22.0	21.0
Wire-cut lug (Dunn)		
3½x4x8½ inches	6.0	7.0
Total	82.1	74.2

The decline in the percentage of shipments of recognized varieties is due to the increased demand for a thinner brick. The 2½x4x8½ in. plain wire-cut brick (not a recognized variety) showed percentages of shipments in 1923 of 2.7 per cent., in 1924 of 4.4 per cent. and in 1925 of 8.9 per cent.

Because of the evident tendency toward the use of thinner brick and because 2½ in. brick have so far stood up well in the brick road test now under way by the Bureau of Public Roads at the Arlington Experimental Station, the committee gave a careful consideration to the advisability of declaring the 2½ in. brick a recognized variety. However, the committee rules provide that, unless there are special reasons, a variety shall not be designated as "recognized" unless its shipments for three successive years have amounted to 5 per cent. of the total. Lacking a unanimous vote (which the committee's rules also require) the proposal to recognize the 2½ in. brick was lost.

Due to the increased use of thinner brick, it is expected that the subject will come up again next year.

The committee's rules for eliminating a recognized variety require that the variety shall fall below 2½ per cent. of shipments for three successive years. Since no variety came under this ruling and there were no special reasons for changes, no eliminations were made.

Asphalt Paving Mixtures in Highway Construction

Latest Developments Outlined in Paper Presented at Second Annual Conference of the North Atlantic States' Highway Officials

By PREVOST HUBBARD
Chemical Engineer, The Asphalt Association

The subject of this paper logically may be considered as a continuation of a former paper on the trend in bituminous pavement design with specific reference to asphalt paving mixtures. In connection with the composition and use of such mixtures the writer feels that the beginning of important advances has been made which ultimately will clarify our knowledge of paving compositions and will broaden and simplify certain of our customary specification requirements.

The New School on Asphalt Paving.—During the past few years a new school on asphalt paving has been developing due to the fact that careful thinking engineers who have been studying the behavior of asphalt pavements under modern traffic have become somewhat skeptical of the logic, if any, back of certain of the specification requirements which have been handed down by an older generation largely responsible for the early development of the industry. The more or less arbitrary specification requirements dictated by the experience of a few pioneers in asphalt paving have as a rule been accepted without question because they seemed to work out fairly well. Careful observers, however, have repeatedly noted that where certain of these requirements have been violated in practice no bad results have followed and in some cases superior pavements have been developed. In other words, it has seemed that while our customary requirements are reasonably safe some of them are unnecessarily and perhaps unreasonably restrictive. This applies particularly to the composition of paving mixtures. On the other hand there is growing evidence that certain construction requirements in particular should be more restrictive and much more rigidly enforced in order to secure the best results.

The Association of Asphalt Paving Technologists.—Recently in Chicago a new association was organized for the specific purpose of investigating and studying all phases of asphalt paving. This organization is known as the "Association of Asphalt Paving Technologists" and is expected to serve as a clearing house for all new and useful information developed upon the subject of asphalt paving. A number of working committees have been appointed, among the most important of which are the one on research on paving compositions and that on control of street operations. The organization of this association is the direct result of the widespread and rapidly increasing interest of the country as a whole in asphalt pavements, an interest of much greater magnitude than the writer believes is appreciated by many engineers whose attention has been centered principally upon the construction of the rigid types of pavement.

Before describing some of the most recent work of investigators who are endeavoring to increase our knowledge of asphalt paving mixtures it is desired to direct attention to a few extremely important construction details which were mentioned in the writer's paper last year but which frequently are slighted because of failure to appreciate how vital they are in producing a durable and otherwise satisfactory pavement. Observance of these details are very essential in the construction of hot-mix asphalt pavements from the standpoint of stability, resistance to scaling, disintegration due to water action and uniformity of contour.

Use of Heavy Roller for Initial Compression.—Undoubtedly the most important single construction detail is initial compression and the use of a heavy roller for first compression of the hot paving mixture cannot be too strongly urged, particularly if the pavement is to be subjected to heavy traffic. In the past it has been customary to roll the fine aggregate asphalt paving mixture, at least, with a relatively light tandem roller, prior to using a heavy roller but this is now known to be far less satisfactory than the practice of using the heavy roller first. A light roller will compact the upper portion of the paving mixture satisfactorily but it fails to compress the lower strata, thereby forming a crust which serves to distribute the load of the heavier roller later used, to such an extent that thorough compaction throughout the depth of mixture is not secured. Such a pavement if opened to heavy traffic immediately after construction, is much more likely to develop waves and ruts

than is a pavement initially compressed with the heavy roller. Even when the heavy roller is used the best results can only be obtained by continuous rolling at a rate not to exceed 200 sq. yds. per hour per roller. This matter is considered to be of such vital importance that during the past year The Asphalt Association has revised its construction specifications, which had previously permitted the use of a lighter roller for initial compression, to read as follows:

> "While still hot the surface course shall first be thoroughly and uniformly compressed by a power driven roller weighing not less than 10 tons. Subsequent compression may be obtained by a power driven tandem roller weighing not less than 5 tons. Rolling shall proceed at an average rate not to exceed 200 sq. yds. per hour per roller continuous rolling for each roller weigh—not less than 10 tons and shall continue until no further compression is possible."

Use of the tandem roller is advisable for diagonal and cross rolling where initial compression has been obtained with a three wheel roller. Considerable care is required, however to use the three wheel roller to best advantage on sheet asphalt or fine aggregate mixtures. The roller should be backed on to the hot mix and operated very slowly, care being taken not to reverse too suddenly. The large narrow wheels cut into the mixture to some extent but compress it from the bottom up so that reasonably uniform density is secured throughout the entire depth of mixture. The extreme importance of maximum initial compression has been demonstrated by laboratory studied of paving mixtures which will be discussed briefly later.

Obtaining Uniformity of Contour.—Uniformity of contour in the newly constructed pavement is the second important construction detail to observe. This, of course, is dependent to a large extent upon the care with which the paving mixture is rolled but even with the best of rolling it cannot be secured unless the material has been properly spread and raked by experienced rakers. The mixture should be combed out throughout its entire depth. The use of a wide-spaced, deep-pronged rake somewhat resembling a potato fork has been used successfully by some progressive contractors and is to be recommended. Where it is necessary that workmen stand at times upon the newly raked material, sandles to the bottom of which are fastened pegs of suitable depth should be worn. In endeavoring to improve the contour of their pavements a number of contractors have found that the use of lutes about 5 ft. in width are of material assistance. An improved method of placing the mixture has also been adopted with good results. This method consists in spreading the mixture so as to produce a working edge in the form of an inverted V with the apex at the center of the road. The rakers can then stand within the V and rake the mixture diagonally toward the center thus entirely eliminating the tendency to produce raking corrugations at right angles to the center line, which are sometimes noted when the working edge is carried directly across the pavement. When the V shaped method of spreading is adopted it will be found advantageous to roll the pavement along lines paralleling the sides of the V after the roller has rolled a single longitudinal strip along each side of the road.

Such rolling also tends to prevent the formation of construction corrugations.

Mechanical spreaders have been used successfully in the construction of certain types of hot mix asphalt pavements and it is probable that they will be used more extensively in all types in the future. A special form of tamping roller has also been devised for the purpose of increasing initial compression but the use of this device is still in an experimental stage.

In his paper last year the writer mentioned the trend toward the use of harder asphalt, a lower percentage of asphalt and a higher percentage of filler in paving mixtures and it may be stated that this trend is becoming more and more pronounced. Considerable information regarding the composition of asphalt paving mixtures has been secured through laboratory investigations which, so far, however, have been confined principally to fine mineral aggregate mixtures.

Stability of Asphalt Paving Mixture.—The Asphalt Association has devised a test for determining and controlling the stability of asphalt paving mixtures which is adaptable for use not only on samples of mixtures prepared in the laboratory but upon core samples of pavements taken immediately after construction or at any time during the life of the pavement. This appartus has been used to study various factors influencing the stability of paving mixtures and has already developed a considerable amount of useful information which, it is believed, will be of considerable value in connection with future work. The method of test was described in detail in a paper presented by the writer before the American Society for Testing Materials last June and only a brief description will here be given.

In the preparation of laboratory test samples a mixture of hot mineral aggregate and asphalt cement first is made under conditions approaching as closely as possible those obtaining at paving plants. From each mixture while hot three cylindrical briquettes are compressed in two-inch cylindrical molds under a load of 3000 pounds per square inch. The

briquettes are then ejected from the molds and allowed to cool over night. They are then placed in a water bath and brought to a temperature of 140°F., the temperature selected for the test of stability, because it approximates the maximum temperature to which the mixture is likely to be subjected under traffic and the temperature at which it is most likely to displace under traffic. The test on each briquette is made in the water bath by placing it in a testing mold of slightly larger diameter with a circular bottom orifice one and three-quarter inches in diameter. A plunger is placed on top of the briquette and a rapidly increasing load is applied until the maximum load required to force the mixture through the orifice is reached. The average maximum load developed by the three briquettes is then recorded as the stability value of the mixture. When it is desired to subject actual pavement samples to this test a short section of 2-in. diameter pipe, sharpened at one end to a cutting edge is jacked into the pavement and when removed brings with it a core sample of the pavement which can be placed in the testing mold and tested after the top and bottom faces have been trued up.

This apparatus has been used in testing a large number of experimental mixtures. It soon demonstrated the fact that the stability of any mixture containing a low percentage of filler is materially increased by the addition of increasing amounts of mineral filler up to a certain point and that different fillers possess different stabilizing values when used in equivalent percentages of the total mix. The tremendous importance of high initial compression has been clearly demonstrated by this test which, for certain mixtures, has shown that stability is almost directly proportioned to the load to which the mixture was subjected during compaction. This factor is of such great importance that it overshadows many of the other factors which have a direct bearing on stability. It may be said, therefore, that failure to obtain high initial compression may result in the instability of a mixture which is inherently extremely stable so far as its composition is concerned. The test has demonstrated that the percentage of asphalt used in the mixture is important also from the standpoint of stability and that, in general, maximum stability is obtained in the fine aggregate mixtures by the use of a smaller percentage of asphalt than has been thought advisable heretofore. This factor, however, is directly dependent upon the percentage of mineral filler used in the mixture and up to the point where the mineral filler actually reduces the percentage of voids in the total mineral aggregate a decreasing amount of asphalt should be used. Beyond this point, however, it is probably necessary to increase the percentage of asphalt due to the increase in surface area of aggregate to be covered.

A knowledge of voidage in the mineral aggregate is believed to be of great importance and general recognition of this fact with the development of a standard method for determining voids may lead to a radical modification in our present grading requirements for mineral aggregate which have always been of a more or less arbitrary nature. As a result of continued investigation on the part of a large number of testing engineers and chemists, coupled with service results, the writer looks forward to a time in the not far distant future when our present grading requirements will be simplified to such an extent as to cover maximum and minimum size particles with some intermediate limitation designed to control the size of voids coupled with a single requirement for maximum percentage of voids in the mineral aggregate.

The stability test which has been described is now being used to ascertain the actual stability values of compressed paving mixtures which have given satisfaction under known traffic conditions so as to establish a range of values which can be specified for mixtures to be used in future construction. In this paper it is only possible to touch upon a few of the high points of the research work that has already been accomplished in discussing the more recent developments in connection with paving mixtures. Definite recommendations based upon these researches are expected to follow as additional data is secured.

Asphalt Base Mixtures.—No paper dealing with latest developments in asphalt paving mixtures would be complete without some reference to asphalt base mixtures, the popularity of which is increasing very rapidly. The characteristics and use of asphaltic concrete bases or foundations were discussed to some extent in the writer's paper last year, so it is unnecessary to cover the same details at this time.

Asphaltic concrete "black base" as you know, consists of a mineral aggregate of approximately 68 percent of broken stone or gravel and 32 per cent of sand mixed with about 5.5 per cent of its own weight of asphalt cement. Both service results and field tests have demonstrated that such a mixture, when properly laid and compressed upon a good subgrade and covered with a standard hot mix top, is extremely durable and more resistant to traffic impact than an equivalent thickness of rigid base. "Black base" may be laid satisfactorily to any desired thickness without danger of breaking up under traffic if properly supported from below and may therefore be employed economically to reinforce an existing old road which it is desired to utilize for foundation. It may also be made

to utilize local mineral aggregate to the maximum possible extent.

"Black base" has a service record extending over a period of more than 30 years and is used successfully under practically all climatic variations occurring in the United States, from Minnesota and Wyoming to Louisiana and Texas and from New York and Viriginia to California. During the past three or four years asphalt base construction has increased rapidly in states east of the Rockies owing to its remarkable success in the far western states which recently has been brought to the attention of Eastern engineers. Last year California alone constructed about 6,000,000 sq. yds. of "black base" pavements, nearly 60 per cent of its total of asphalt pavements laid during that year being of "black base" design.

One of the recent developments in connection with "black base" construction which has been sufficiently tried out to warrant recommendation is the use of mechanical spreaders for distributing the hot mix. Mechanical spreaders may be used economically not only for spreading a uniform layer of mixture across the roadway, but for spreading narrow strips along the sides of old roads which are to be widened. In such work it has been found possible to spread as much as 400 tons of mixture per day with a force of only four shovelers and three rakers.

While much more might be said at this time about "black base" the writer does not wish to digress from the subject assigned and in conclusion will state that in his opinion the most significant development in connection with "black base" construction in the East is its growing use as a means of salvaging old roads which have passed their period of serviceability as wearing surfaces and which are not sufficiently thick or stable to be utilized alone as foundations for new wearing courses. Such practice, if followed conscientiously, will save this country many millions of dollars which are tied up as an investment in old roads and which would be lost or thrown away if such roads were replaced with new construction entirely.

Minnesota Research Projects

The Minnesota Highway Department, according to April Highway Research News, has the following investigations either in progress or proposed:

1. Laboratory investigation of effect of calcium chloride both as admixture and for surface curing. The investigation is comprehensive and will include the testing of 750 specimens. The Department is contemplating the use of calcium chloride in the mix and not requiring any other form of curing. All the Portland cements purchased for 1926 pavements will be used in the investigation. To be completed by June 15.

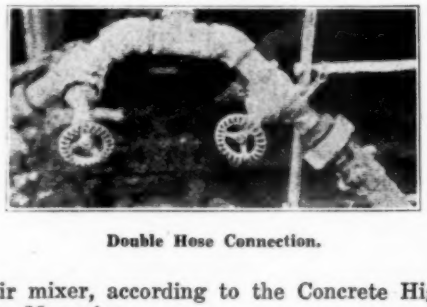
2. Laboratory investigation of effect of freezing concrete at different ages. The purpose is to obtain additional information on how long concrete should be protected before freezing is permitted. Investigation will be completed about May 1.

3. Field and laboratory investigation on bituminous treatment of gravel roads. Investigation started in 1925. The object of this investigation is to ascertain the best bituminous materials for the various classes of gravel (according to laboratory analysis) and proper means of applying and maintaining. Date of completion problematical.

4. Field and laboratory investigation of durability of paints. Panels of different wood and metal paints are to be placed on rack and observation made at definite intervals. Time of completion problematical.

Double Hose Connection on Mixer

During the past season Foster & Creighton Co., of Nashville, Tenn., added 50 to 75 sq. yds. a day to their concrete pavement yardage by putting a double hose connection on



Double Hose Connection.

their mixer, according to the Concrete Highway Magazine.

Two 100 ft. lengths of hose were used with double hose connection and one was always attached to both mixer and water line, ready to supply water. The idle hose was carried ahead by two handy men who attached it to the water line. When the mixer had advanced far enough the idle hose was attached to the spare connection and the water turned on. Then the other hose was disconnected and carried forward.

Usually one hose supplies mixing water. Two or three times a day the mixer must be stopped while most of the crew carry the hose ahead and attach it to the next tee in the water line. In that way the average mixer loses from 20 to 35 minutes a day.

County Park Development in Iron County, Michigan

Work of County Road Commissioners Described in Paper Presented Feb. 16 at 12th Annual Conference on Highway Engineering at the University of Michigan

By H. F. LARSON,
Engineer Manager, Iron County Road Commission

We started in about 8 years ago with the idea of trying to preserve for posterity at least a portion of the county's beauty which nature had so richly bestowed upon us. The Board of County Road Commissioners called the facts to the attention of the Board of Supervisors and they in turn appointed the Road Commission as "Park Trustees." At that time the amount of money which could be raised for Park purposes was very limited and it became a problem to finance the project. This was finally overcome by using a modified form of Henry Ford's famous five dollars down and five dollars a week plan. Since that time the law on County Park sites has been changed which enables a county to do more along this line.

The first tract of timber bought was in 1918, a half section of beautiful virgin hardwood timber located on M12 midway between Crystal Falls and Iron River. While it is not situated on a lake it is a beautiful sample of what our virgin hardwood forests were and it is our intent and purpose to have this tract kept in its natural state for the enjoyment of all who drive through it.

Right of Way Through Timber Tracts.—Where our roads run through virgin timber tracts we have bought up additional right of way. In most instances we have been able to buy an entire forty just as cheaply as we could purchase a strip of land, for in many cases the road cuts up a forty leaving very little after additional right of way has been purchased. The value of this timber along our highways can hardly be estimated in dollars and cents. From the standpoint of beauty it is well worth the money but in the matter of "Snow Removal" it has its greatest value. It isn't so much the amount of snow which gives us the greatest trouble as it is the continual drifting. If we can protect a good share of our highways with its present standing timber, and in lands where the timber is now cut, encourage the second growth to come up, or plant evergreens such as spruce, balsam and pine, we will have gone a long way in the solution of our snow removal problem and besides will have added to the beauty of roadsides.

What a Lumber Co. is Doing in Conservation.—I would like to call your attention to what the Von Platin Fox Lumber Co. of Iron Mountain, Michigan, of which Mr. M. J. Fox is manager, has done in the matter of conservation. A few years ago I received a letter from Mr. Fox stating that when his company began logging operations along M12 between Beechwood and Watersmeet they would leave a 200-ft. strip of timber on each side of the highway so the scenic beauty of the wonderful drive through the present almost unbroken forest would be preserved. One driving along in the summer time when the foliage is thick would hardly believe that in spots a few hundred feet back the timber had been cut. Inasmuch as this will involve a considerable mileage Mr. Fox certainly can not be complimented any too highly for his public interest in doing what he has to preserve the scenic beauty of this drive. We wish we had more public spirited lumber companies of this sort. Mr. Fox has also presented to the county free of charge and without being solicited, a tract of land of 54 acres covered with a beautiful growth of virgin hardwood and hemlock trees located along M12 on the shores of Golden Lake. This is now called "The Von Platin Fox County Park" and it is at the present time practically undeveloped save for a few lunch tables scattered along the shore line.

Bewabic Park.—The county now owns about 900 acres of public parks which are well distributed. Realizing that as years go by lake frontages would be rapidly taken up by private people and the time would soon come when a family could not stop, set up a tent for the night, or have a basket lunch without trespassing on private property, the county has included in its park system some beautiful lake sites. Bewabic Park (meaning Iron Park) located on a chain of four lakes called Fortune Lakes, consists of 112 acres of which about 60 acres are cleared land and suitable for cultivation. The rest of the tract is covered with virgin hardwood timber. It is a beautiful spot, the land being of a rolling character and sloping toward the lake, the place was originally

started as a farm and a fine residence and barns are located on the property. It is our intention to turn this residence into a club house. There is now a movement within the county to build a nine hole golf course here. A golf architect who made a preliminary survey

View Along One of the Highways of Iron County, Michigan

of this site made a report to a committee of citizens who hired him that the grounds were ideal for this purpose. Lunch tables are scattered here and there in shady spots along the lake shore and throughout the heavy timber back from the lake for the use of auto parties. People who desire to camp here are charged a fee of 50 cts. the first day and 25 cts. for each following day. No voice has been raised against this charge as everyone agrees that it is perfectly proper. A bathing beach and change houses are maintained free of charge for the public and during the bathing season is well patronized. This coming summer two tennis courts will be provided. There is ample room for the parking of automobiles and plenty of space for both indoor and regular baseball. A regular caretaker is provided on the grounds who is also deputized. He is paid a salary of $60 a month with the right to all concessions and during the summer months does a very good business. As this park is a large one we also intend to fence in about 20 acres along M12 and place within the inclosure native deer and possibly other animals. The site picked out contains both grazing and cover land and will make an ideal natural deer yard.

Monuments to Past Industries.—We have one feature here to which I would like to call your attention. We have erected as a permanent monument to a past industry a white pine butt log which measures four and one-half ft. on the stump. This log, which is 16 ft. long and has the regular lumberman's identification mark stamped upon it, was donated to the county by W. A. & H. Holmes, lumbermen of Iron County. The log lies off the ground on two concrete abutments and is protected from the weather by a cedar canopy built much on the order of a Chinese pergola. To further preserve the log it is covered with four coats of water spar. The monument being unique has occasioned considerable comment. While larger timber occurred in this section of the country this is a representative specimen of what the white pine really was. A brass plate on one end of the log bears the following inscription: "Donated to the County of Iron by W. A. & H. Holmes in memory of a past industry."

Every state in the Union is striving to save its historic spots and suitably mark them with tablets or monuments. Many private persons, are doing everything possible to stimulate interest in local history, to conserve and mark historic spots and preserve for future generations exact knowledge of the aborigines and pioneers.

Pentoga Park.—We have included in our park system the site of the old Indian village of Chi-cau-gon, located at the head of Chi-cau-gon Lake and now called Pentoga Park in honor of the wife of the last chief who lived at the Lake. We sincerely hope that some day the "Park Trustees" will see their way clear to erect a suitable and lasting memorial to the Ojibways in this beautiful park. Every county in Michigan is rich in Indian and pioneer history, some a good deal more than others. The trouble with most of us is that we know where these places are but think nothing of them until it is too late, little realizing what interest they may hold for future generations. This was what was happening at Chi-cau-gon Lake. The old Indian village site and burial grounds were being platted into lake frontage lots and some had been sold when the county stepped in and bought up the site. The old Indian burial grounds were cleaned up, new houses built in place of the old ones which had long ago rotted away leaving scarcely identification marks on the ground. While cleaning up the grounds many old trinkets were found, such as old guns, arrow heads, traps, axes and tomahawks.

The labor used in cleaning up most of our park sites has been jail labor. At one time we

were very fortunate in having several Finnish carpenters in jail who constructed a very artistic gate way to this park out of cedar logs. The design being unique has attracted considerable attention.

A wonderful bathing beach is located in the park; the water is very shallow near shore making it ideal for small children. A changing house for the bathers is also provided. Lunch tables are scattered along the lake shore which is fringed with a beautiful stand of second growth maples. Where the old Indian corn fields once stood is now used as a playground.

A full blood Ojibway Indian caretaker is provided who looks after the place. He is paid a salary of $60 a month with all concessions. We have tried to give this place an Indian atmosphere by having the caretaker and his family live in a wigwam in regular Indian style so people get an idea of how they actually lived. Of course a regular cottage is also provided. The park consists of about 12 acres, and is for the most part covered with a second growth of oak, maple and poplar trees. The lake on which it is located is about 4 miles in length and is today as it was in the days of the redman, a very popular place.

Several years ago after the Indian cemetery had been reclaimed the remnant of the tribe together with their friends and relatives, about 50 in number were invited back to the old site for a three day pow-wow. Anniwabi, one of the most prominent Indians of the North, in the name of the Ojibways made a very strong speech in which he thanked his pale face brothers for what they had done in preserving their old home.

What Is Being Done in Reforestation.—In the matter of reforestation we have made a modest beginning. In the past four years we have planted in our various county parks approximately 20,000 white pine, norway pine, and spruce seedlings. These seedlings were obtained free of charge from both the Conservation Commission and the Michigan Agricultural College. Taking the project as a whole it has been thus far successful. The small trees are doing very well. We lost some last spring due to the severe forest fires and some which vandals pulled up by the roots. In a matter of 10 years these trees will make a good showing. We have been doing this work more or less as a demonstration of what can be done along this line. Fire which is reforestation's greatest enemy, must be watched very closely for even a grass fire is hot enough to kill pine trees even after they get to be quite a size.

Other County Parks.—The various parks which the county now controls besides Pentoga and Bewabic, which have been described, are namely the Fair Grounds, which consists of 40 acres and is located in the city of Iron River, where the annual County Fair is held. It is also in use as a baseball and football field by the people of Iron River. Chi-cau-gon Creek Park, 160 acres, located along M12, is undeveloped and probably will be so for some time to come. Crystal Spring Park located on M69

Entrance to Bewabic Park

is a small park of about 2 acres. Several years ago the timber in this vicinity was being cut and the spring located along the highway was situated in a hemlock thicket. Arrangements were made with the United States Steel Co., for its preservation. The United States Steel Corporation permitted us to fence in this park for a rental charge of $2 per year Lunch tables are provided, also fire places where tourists and auto parties may stop and eat their lunch. We have several more sites such as these with lunch tables, etc., but they are not fenced in as the county as yet does not own them. Every year we shop around and try and find out at least a year ahead what timber is to be cut and try and make arrangements for the preservation of that portion which adjoins the highway.

We are now negotiating with the owners for the preservation of 10 miles of timber along M69, north of Amasa, for 5 miles along M73 and for a similar tract along county roads A and D. Most of the lumber companies to date have given us the hearty co-operation and we

believe we will be able to come to terms with the others. Tourists tell us that we are to be complimented for this far-sightedness as it makes a wonderful drive out of which would soon be a barren stretch, and is a great drawing card for the county.

Believing that game and wild life in general should have a "Rest Haven" we have posted all our parks as "game preserves" and notified all game wardens to enforce Act 117, Public Act, 1921, Section 275, which prohibits hunting in and out of season on all such lands. You may perhaps be surprised when I tell you that it does not take the wild life long to find this out. I believe the only solution for the preservation of our game is to provide such areas and this should be done by both the State and County. The game when hunted will thus have a haven to run to and if he gets by the battery of guns which are after him he should be allowed to live.

Chippewa Indian Cemetery at Pentoga Park

Park Rules and Regulations.—Some of the Rules and Regulations which govern our parks are as follows:

1. Persons destructive to trees, buildings, signs, equipment, flowers, shrubs, etc., will be prosecuted.

2. Garbage is to be deposited in cans provided for that purpose.

3. Tourists desiring campsite to see caretaker in charge. A charge of 50 cts. for the first night is made and 25 cts. for each succeeding night.

4. No person shall, without written order, sell or offer for sale within the park limits any merchandise. This privilege is given only to the caretaker as part payment for looking after the place.

5. No hunting is permitted in or out of season.

6. No signs are to be posted within the park without permission.

7. No gambling is permitted.

8. All camp fires must be extinguished before leaving.

9. No person shall take photographs or moving pictures within the various parks for the purpose of selling the negatives thereof or prints therefrom without having first received a written permit.

10. Speed limit within the parks 20 miles per hour.

The above rules and regulations will be enforced according to the laws of the State of Michigan and the County of Iron and any person violating the above will be prosecuted.

We have approximately 900 acres of so-called park lands, only three tracts of which are developed. It is our present policy to acquire additional sites that are still available and leave them undeveloped rather than spend much money at this time for development for we feel that when the time comes development will take care of itself. We also propose to acquire many small sites along our lakes and rivers, so picnickers will not be confined to one or two places.

Prosecuting Highway Construction

The Dominant Factors Entering Into the Carrying Out of a Job Described in a Paper Presented Jan. 12 at 23rd Annual Convention of American Road Builders Association

By W. R. SMITH
President Lane Construction Co., Meriden, Conn.

In the prosecution of highway work there are three dominant factors—the weather, the engineer, and the contractor. I think these factors have been mentioned in the order of their importance.

The first factor, fortunately, is beyond human control. Rain and snow, heat and cold, are furnished for the best interests of all, but there are times when the elements seem to be handled in a very haphazard way.

The Engineer.—The second factor in progress—the engineer—is the dominating human factor. He designs the project, lets the work, dictates the construction, accepts the job when his ideas are exhausted, and settles with the contractor, mostly on his own terms.

Trouble in progress often starts in the award of work because of the more or less general practice of awarding to the low bidder. If the public knew what that practice has cost this country, a cry would rise from coast to coast. Laws should be changed and authority given the awarding body or engineer to use discretion in award. The awarding body today deserves the confidence of the public and should be allowed to do business along business lines. The idea that engineers are grafters and contractors crooks is not true. We are doing business in seven eastern states and all engineers or awarding bodies with whom we do business are, and have been for years, absolutely above the thought of any easy money for themselves or the contractor. Highway contractors may not be saints but the thieves are few. The award should go to the lowest satisfactory bidder. A man's record should count for more than it does. It is not always the man who has the best banking connection; he often fails in his organization. It is the honest man, the man in responsible financial condition, with a knowledge of the work which he undertakes, and who can show progress, to whom work should be awarded.

Causes of Delay.—I would like to call the attention of the engineering departments at this time to a few points over which they have absolute control and which are often the cause of delay to work. Sometimes a department, in its haste to get out work for bids, will submit work that is really inaccessible. We have had frequent occasions where it was impossible to get at certain parts of the job due to the fact that right of way on new location had not been acquired or that release of land for easements or drainage privileges were not to be had. We have also had instances where awards have been temporarily held up for lack of financing. Such things as these seriously interfere with progress and are not only exasperating to the contractor, but expensive.

The Inspector.—The inefficient and ignorant inspector, I feel sure in saying, is the contractor's biggest annoyance. The trouble is absolutely due to states and municipalities not forming engineering organizations adequate for work involved. A good contractor realizes that his organization can only be held by being paid in reason. One capable engineer, receiving adequate compensation, with one reasonable assistant, is worth more than the engineering mobs, often made up of kids and incompetents, that are seen on many jobs.

To the great number of competent inspecting engineers is extended a most sincere appreciation of their worth. A good—by that I do not mean an easy—inspector is a job's great asset.

As a contractor, I have not the least patience with states or municipalities attempting to force speed on work by suggesting a penalty for lack of completion within a specified time unless they offer a bonus to the contractor for an early date of completion. The idea is wrong in theory and does not work out in practice.

Lack of Sufficient Information.—One of the most annoying things in connection with work is that not sufficient information is given the contractor as to what will be required of him before his work is accepted. Often times, due to this lack of information the contractor transfers men who should be held, moves plant before it should be released, and makes his plans allocating superintendent weeks before it can be accomplished. This delay in work is largely due to the ideas of the inspector not being given the contractor. In many cases, the contractor has the ideas of the inspector

in regard to completion; then the assistant division engineer will come on the work with new thoughts; he is probably followed by the division engineer who may or may not agree; and lastly the chief engineer in charge of construction appears with his demands. There is an argument between the engineering force and the contractor as to whether he has or has not been told to do certain things.

This last season, for the first time in our history, we met, to my mind, an ideal engineering situation. After the pavement was completed on a contract and while we were working on shoulders and incidental work an engineer appeared and went over the contract carefully with his inspector and our superintendent. The next day our superintendent received a letter stating that when such and such things were done the contract was accepted, the inspector on the job receiving a copy. In this particular instance, there were 35 things mentioned like lowering this ditch, removing a rock at Station —, opening entrance to culver at Station —, cutting back slope between Stations — and — removing stump, Station —, cutting tree, Station —. As soon as the superintendent received this list, he was absolutely in a position to plan relieving plant and so organize as to quickly finish the work with the least possible expense and delay.

The Contractor.—The third factor in highway construction is the contractor, and three things he must have—men, plant, and money. The ability to execute is the big factor and all the plant a machinery man can sell you is helpless without human assistance. It is organization that makes execution possible and organization is the great big factor in progress and success. Perfection of organization is a matter of growth. The men in our corporation are the survivors of many contract battles through a long period of years.

While handling several contracts at a time, we find a great help in progress lies in our ability to continually transfer men and plant from one job to another. Somewhere we generally have the engineer, or foreman, or machine required. It is easier to make progress on a lot of work than a little. I do not mean to decry the man who is working one contract. He may be the big operator of the future.

The Daily Progress Report.—We are using a form for a daily progress report. This report is made up by cost clerk on the work in triplicate and signed by the superintendent, who keeps one copy, sending one form to home office and one to division engineer. These reports carry a good deal of really valuable information but perhaps are not the assistance in progress you would expect.

Prosecuting the work and keeping intelligent costs are two things that should keep in step but often march away from each other. It is much easier to carry on work than to get intelligent costs, but the knowledge of the detail of costs is absolutely necessary to prosecute work in reason. The speed at which work should move lies somewhere between made haste and slovenly delay. It is only in a special instance that the progress of work should not follow the way of least cost consistent with satisfactory results.

Regarding intelligent costs—The human element has destroyed our hope of keeping costs exact but I would insist they are intelligent. After an experience of 35 years, I offer to you our first conception of cost method, with only minor changes made from time to time.

Cost Keeping System.—When a contract is awarded, we give it name and number which are entered on one of our cost sheets and inserted in a loose leaf cost book.

All bills against a particular contract, as fast as they are properly approved and classified, are entered on the cost sheet at home office. The first column shown on the sheet is for date of invoice; the second, for name of the payee; the third, for quantity—wherever occurring, like tons of stone, gallons of asphalt, barrels of cement, feet of pipe. The quantities showing in quantity column are used in securing unit costs during progress of work and the checking of final estimate. The fourth column carries the total of invoice. Then follow columns headed to cover different items of cost desired, the sum of the classified items, of course, balancing the total, and once a month the cost sheet total is balanced with the ledger.

A classification sheet, bearing the same cost headings as cost book, must accompany all payrolls from the field to main office. The classified daily cost balances with payroll. The total classified payroll is entered on cost book—same as invoices.

On completion of the contract, totals are brought to the bottom of the cost sheet; unit costs are worked out; unit receipts as shown against the cost; the total profit or loss of the job, and the percentage of profit or loss are computed. Everything of cost that can be shown against any one job is on this sheet. The cost sheet does not carry insurance, taxes, general repairs, depreciation or salaries other than that of men detailed to a particular job. This overhead is worked into a percentage on ousiness done.

Depreciation as an item of cost does not receive the consideration it deserves. We take annually all the depreciation the Government will allow, but it is rarely we can sell used plant at its book value. Actual depreciation

will put a fine nick in any contractor's profits and it is too often overlooked or greatly underestimated. Dead plant is not of any more value above ground than below; in fact, we burned and buried considerable this year.

Our field timekeepers or cost clerks, from their classification of payroll, have the information to give the superintendent field costs daily or as often as he may require. Our division engineers are given detailed costs once a month of work under their charge, and work up their own unit costs when desired. Our general manager is given the total cost of each contract every week. When estimates are received, he places the amount of the estimate against the cost of the nearest corresponding date. At the end of the year, all costs are carefully tabulated and then used as an element in future bidding.

Thus, in a general way, it is possible to tell continuously whether you are coming or going and put the best thought of your organization on the condition where it is most needed.

Portland Cement Association Moves to Its New Home

The general offices of the Portland Cement Association, which for the past 10 years have been in the Conway Building, 111 W. Washington St., Chicago, have been moved to the Association's new building, Grand Ave. and Dearborn St., otherwise known as 33 West Grand Ave. The entire building is occupied by the Portland Cement Association and its research laboratory. For the past 10 years the laboratory has been located in the Lewis Institute, Madison and Robey Sts., and heretofore conducted co-operatively by the institute and the association.

The architects, Holabird & Roche, have produced a handsome 5-story and 2-basement building, resting on 30 concrete caissons carried down to firm bearing. This structure is regarded by engineers, architects and builders as representing the highest type of fire resistive construction and also as a worthy addition to the rapidly growing list of structures which typify the architectural possibilities of concrete.

The Turner Construction Co. of Chicago and New York, which was awarded the contract for this building, began excavation in August. The greater portion of the work was carried on during cold weather. The usual precautions of heating aggregates and protecting concrete from freezing were followed. Floor by floor, the building was enclosed with tarpaulins and heated with salamanders. As a matter of fact, winter temperatures were in no sense a handicap to the orderly and scheduled progress of the work.

Foundation design provides for adding stories to the building if enlargement of Association activities demands more space.

The sub-basement contains the heating, mechanical and electrical equipment servicing the building. The heavier Laboratory testing machines are installed in the basement proper, which also contains moist rooms and other facilities for storing the thousands of concrete cylinders which month by month and year by year as they are submitted to test, disclose the results of the many carefully planned researches constantly being conducted.

Other laboratory equipment, a laboratory machine shop, shipping and receiving rooms for the building, reception room, information desk and telephone switchboard are on the first floor. The lobby is a revelation to those unfamiliar with the possibilities of precast concrete stone. Lighting in the reception room is from flood lights, mounted on precast concrete standards.

The precast stone stairway leading to the second floor contributes to other architectural attractions of the lobby. On the second floor is the chemical laboratory and the offices of the director of research and his assistants. The general storage facilities for bulletins, records, etc., are also on this floor. In addition there is a small auditorium and stage.

The third floor is devoted to offices of the structural, railways and cement products bureaus and to the Association's reference library. The library probably contains the most comprehensive collection of literature devoted to the uses of cement and concrete in existence. It is a public library in charge of trained librarians, whose services are always at the disposal of architects, engineers, contractors or any others who desire to avail themselves of its many bound volumes and extensive reference files on the uses of cement and concrete.

Stenographic and mailing departments are on the fourth floor.

The offices of the general manager, assistant general manager and several of the general office bureaus such as advertising, publications, general educational, highways, accident prevention, auditing, purchasing, are on the fifth floor. There is also a conference room for staff meetings.

The architects co-operating with the association's building committee and its engineers have provided a building which is distinctive not only because it is substantial and firesafe, but because it expresses the economies capable with reinforced concrete design, as well as the architectural possibilities of concrete from the standpoint of art in architecturel.

C. L. McMullen Elected President of Fuller & Johnson Mfg. Co.

At the recent annual meeting of the stockholders and directors of the Fuller & Johnson Mfg. Co., Madison, Wis., the following officers were elected: C. L. McMullen, formerly vice president, president and director of sales; W. W. Gore, vice president, director of engineering; C. K. Swafford, vice president, director of production; H. C. Wolf, treasurer, director of purchases; Paul Kney, secretary, director of credit and finance, and M. J. Esser, assistant treasurer, director of accounting. The above officers constitute the Board of Directors.

C. L. McMullen began his career with the Fuller & Johnson Mfg. Co. in 1902. In 1912 he was appointed Sales Engineer, from which he advanced to General Sales Manager, Vice President and Director of Sales and now to his present position as President of the company. With his broad engineering and merchandising experience in the industrial field,

C. L. McMullen.

he comes well fitted to assume the added responsibility as head of one of the oldest and best known gas engine manufacturers in this country.

W. W. Gore, Vice President and Director of Engineering, recognized as one of the leading gas engine designers, is responsible for many patented features embodied in the design of the new Fuller & Johnson engines.

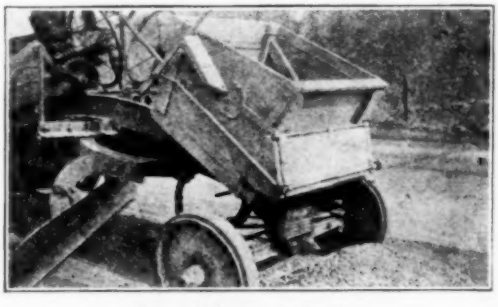
C. K. Swafford, vice president and director of production, is well known as a production engineer. In 1920 he was appointed general superintendent from which he has advanced by recent election to vice president and director of production. Mr. Swafford reports many recent revisions and improvements in production methods effecting economies as well as refinements in the production.

The company during the past year has added several new sizes and types of gasoline engines. These developments which have materially broadened their line, account in a large measure for the very substantial increase in their business this year.

Gravel Hopper on Power Grader

A gravel hopper attached to a one-man grader is used in patching rock shoulders in Division II of the California state highway system. The outfit was developed by E. L. Stump, Superintendent of Maintenance of his Division, who reports it economical and serviceable in keeping rock shoulders flush with the pavement and in good travelable condition. The arrangement is described in California Highways.

The hopper will hold a third of a yard of crushed rock or gravel and is so adjusted that



Gravel Hopper on Grader.

small amounts of rock may be dropped here and there, where needed, as the grader moves along the shoulder. Small depressions are filled with surfacing which is immediately spread to a true grade by the blade of the grader.

The extra weight of the hopper and contents does not seriously overload the equipment, the division says, but rather has a beneficial effect in steadying the grader, making the blader operation more thorough and effective. The cost of the outfit complete and installed is about $25.

Construction Engineers Wanted.—The California State Civil Service Commission, Forum Bldg., Sacramento, Calif., has announced that examinations will be held for junior construction engineer, bridges, grade 3, and assistant construction engineer, grade 4. Salary for grade 3 is $170 to $230 a month; for grade 4, $235 to $280. May 31, 1926, is last day for filing applications.

Widening and Thickening California Roads

Work of California State Highway Department Outlined in California Highways

By R. M. MORTON
State Highway Engineer

The highway department follows several plans in the widening and reconstruction of pavements. The type to be used on a specific project is chosen after a study of the physical features. Availability of materials, condition and width of pavement, alignment, grades and soil conditions enter into the choice of type. The present and probable future traffic are considered in planning the width.

Most of the original pavements built by the state are of Portland cement concrete, 15 ft. in width and from 4 to 5 in. in thickness. Many miles of county-built pavements of varying types and widths, generally of light construction, have been incorporated into the state's system.

Widening work includes concrete shoulders built flush with the existing pavement; raised concrete shoulders and asphalt concrete surfacing; asphalt concrete shoulders and surfacing for the full width and second story concrete shoulders and resurfacing. In locations of light traffic and where suitable materials are available, oiled macadam shoulders are sometimes built.

Future Program Is Large.—About 600 miles of state highway pavements have been already widened, of a total of about 2400 miles. At lease 1500 miles more will require widening as fast as funds are available.

The original width of pavement constructed from 5 to 15 years ago was 15 ft. This width becomes overstressed with a traffic in excess of 1000 vehicles per day. Corner breaks and settlement of the edges occur, and it is impossible to keep shoulders flush with the pavement. Our traffic counts indicate that a 20-ft. pavement readily handles a traffic up to 6000 vehicles per day, and is not overstressed until 10,000 vehicles per day is reached. When the traffic exceeds that amount, additional widening or a second road is considered necessary. Often, however, this heavier traffic occurs in suburban districts where the building of a full width street, with curbs and gutters, is required, and a large portion of the cost is defrayed by the adjacent property owners. The width generally adopted for the average pavement reconstruction is 20 ft.

Where the existing pavement is in good condition, cement concrete shoulders 2½ ft. wide and 7 in. in thickness are placed at either side of the existing 15-ft. slab. In preparing subbase for this type of widening, the soil is excavated for several inches beneath the edge of the existing pavement to form a joint and give added strength to the edge of the old pavement. Most work of this nature contemplates future surfacing over the entire width of the pavement.

It is usually required that only one side of the highway be worked on at a time in order that there may be no interruption to traffic. During 1924 California completed about 26 miles of this type of widening at an average cost of $10,493 per mile. This also included the widening of grade from 21 ft. or 24 ft. to 30 ft. and the extension of culverts.

Combination Proves Successful.—A type of widening and thickening which has proven successful is a combination of concrete shoulders and asphalt concrete wearing surface. The shoulder is laid 7 or 8 in. thick at either side of the existing concrete slab and raised about 3 in. above it. An asphalt surface not less than 2 in. in thickness is placed over the old pavement and extends into an offset built into the new concrete shoulder, thus making a perfect seal and water-tight joint.

This type of surfacing and widening is placed where the existing concrete base is still in fairly good condition but where it may be predicted that the end of its economic life is fast approaching. About 180 miles of concrete highways have been widened and thickened by this method at an average cost of $22,400 per mile.

A variation of this type is the construction of asphalt shoulders instead of concrete shoulders. Under this method a base 2½ ft. wide and 4 to 5 in. in thickness of asphalt concrete is placed at the side. This is followed with a leveling course of asphalt, and a wearing surface completes the job. The cost of this type of work on a typical project, which includes rather heavy grading quantities and the lengthening of many drainage structures, was approximately $30,000 per mile. For the paving alone, the cost is usually little less than the cost of an installation of concrete shoulders and asphalt center.

This plan has been successfully used on widening oiled macadam highways. The first step usually consists in placing a macadam foundation at the side of the existing oiled macadam highway and permitting it to remain open to traffic over a season. This is followed by the placing of a leveling course over the old pave-

ment and the new shoulders, which is followed with a wearing surface of the same material. One typical project of this nature in 1924 cost about $24,000 per mile for an 8½-mile section.

Oiled macadam roads have been widened, thickened and leveled with asphalt concrete in varying widths. The thickness of the new surfacing usually varies from 1½ in. to 3 in. The aim of such work is to improve riding qualities of the surface and utilize the old base as a foundation. Such work will average $10,000 per mile in cost.

"Second Story" Concrete.—The most costly type of reconstruction is the second story concrete. This consists of a slab of concrete usually 20 ft. in width placed on and overlapping the edges of the original 15-ft. pavement. For this work the standard thickness is a minimum of 5 in. in the center, increasing to 7 in. at the edge of the old slab and 9 in. at the outside edge. Special attention is paid to the subbase under the overlapping edge of the new pavement, and the extensions beyond the edge of the old pavement are reinforced with steel. Transverse and longitudinal joints are placed.

This type of resurfacing is usually chosen where the old pavement is broken and in poor condition, having reached the end of its economic life. About 78 miles of this type of reconstruction have already been installed at an average cost of about $31,720 per mile, including widening the grade and lengthening drainage structures.

Heavy Pavements Needed for Traffic.—California has widened state highways to widths of 20, 24, 27, 30, 40 and 56 ft. On one particular job a 24-ft. asphalt surface on a concrete base was widened to 40 ft. by means of 8-ft. concrete shoulders on both sides, 8 in. in thickness with 10-in. edges. The old asphalt center was dressed up with a new asphalt concrete wearing surface. On this width of highway separated into traffic lanes by the appearance of the materials, the slow moving commercial traffic tends to concentrate on the shoulders at the side, leaving the center free for faster traffic.

The most costly completed section of state highway reconstruction was completed in 1924 near Los Angeles, with the cooperation of the county and an improvement district. The old 20-ft. oiled macadam roadway was replaced with a street 56 ft. wide between curbs. A subbase of decomposed granite was first placed, then a 7-in. Portland cement concrete base finished with a 2-in. asphalt concrete surfacing. This improvement cost approximately $150,000 per mile.

New Face Rail Clamp

A new face rail clamp for curb and gutter forms has been developed recently by the Heltzel Steel Form & Iron Co., Warren, Ohio. This clamp or overhead hanger as it is some times called is made with hook bolts on both ends which hook down onto the top flanges of the front and back rails. A long wing connected

Heltzel Curb and Gutter Form

with the face rail claimp extends through a slot in the top of the face rail, etxending down its entire depth, prevents the face rail from spreading. Near the top of this wing is a small piece of angle iron which rests on top of the face rail, preventing it from creeping up and giving clearance under the face rail clamp for the use of finishing tools. The division plate is made with long wings on each end which hook down through slots in the front and back rails, preventing them from spreading.

New Road Marker

A new marker, just perfected, consists of a rubber block carrying the necessary markings vulcanized under heavy pressure to a steel plate ¼ in. thick. This is imbedded in the road flush with the level of the pavement. The new rubber marker is being exploited by the American Road Marking Sytsem.

51 Steam Roads Use Trucks.—According to a survey of the Motor Truck Department of the National Automobile Chamber of Commerce, 51 steam railroads are using motor trucks to handle freight as compared with 33 a year ago. Twenty steam railroads or their subsidiaries, are now using over 219 motor busses, it is stated.

Transverse Distribution of Trucks on Roads

Observations from a Study of Highway Traffic in Cook County, Illinois

Studies of highway traffic in Cook County, Illinois, were conducted during the summer and fall of 1924 under the cooperative research agreement between the U. S. Bureau of Public Roads and the Cook County Highway Department. The matter following is extracted from the recently issued report of the study.

Figure 1 shows the observed transverse distribution of trucks on the highways in Cook County. The distance from the curb to the outer rear wheel of the truck was recorded on highways with 18, 24 and 27-ft. pavements. The 27-ft. pavement was limited to one-way traffic. In the case of the 18 and 24-ft. pavements, the distance from the curb was measured at 6-in. intervals; in that of the 27-ft. pavement, at intervals of 1 ft.

There is a marked difference in the transverse distribution of the outer truck wheels on the different widths. Figures 2 and 3 present these distributions as percentages of the number of wheel passages on each foot of width, in order to establish a common basis for comparison.

The most important conclusion to be drawn from this study is that, so far as trucks are concerned, increasing width from 18 to 24 ft. has a comparatively small effect upon transverse distribution. On the 24-ft. pavement the distribution is moved approximately 1 ft. further from the curb. On both the 18 and 24-ft. pavements the outer rear wheels of over 40 per cent of the total number of trucks pass over a strip of pavement 1 ft. in width. On the 18-ft. pavement this strip is 2 ft. from the curb and on the 24-ft. pavement 3 ft. from the curb. Eighty-nine and five-tenths per cent of all trucks using the 18-ft. highway travel with their outer rear wheels within 3 ft. of the curb while 70.2 per cent of all trucks using the 24-ft. highways travel within the same distance of the curb. The distribution is quite similar in both cases, and were the "over-3-ft." group on the 18 ft. width distributed, the distribution would undoubtedly follow

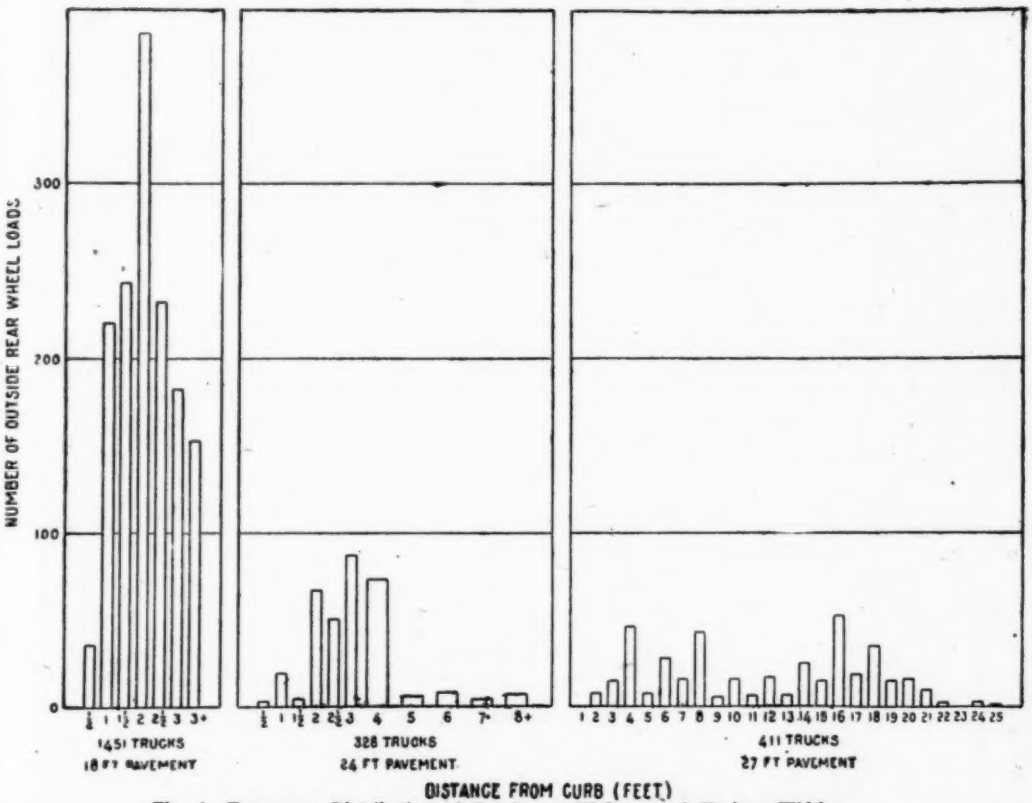


Fig. 1—Transverse Distribution of Trucks on Highways of Various Widths

closely the distribution as shown for the 4, 5, 6, 7, and 8-ft. strips of the 24-ft width.

Figures 2 and 3 show the difference between the 18, 24 and the 27-ft. pavement widths.

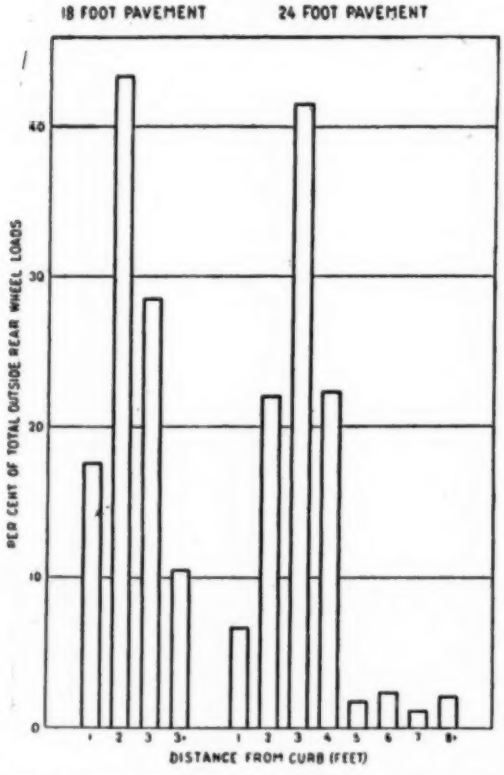


Fig. 2—Transverse Distribution of Trucks on 18-ft. and 24-ft. Pavements by Percentages of Total Number of Wheel Passages

With an average body width of 7.3 ft., a 27-ft. pavement permits three lanes of trucks with ample clearance between vehicles. The maximum number of trucks is found 16 ft. from the curb on the 27-ft. pavement.

New Grader Blade

The development or adoption of a new grader blade stock that is claimed to give from 25 per cent. to 30 per cent. more wear, is announced by J. D. Adams & Co. of Indianapolis, manufacturers of Adams adjustable leaning wheel graders and other road building and maintenance equipment. This announcement follows a 2-year period in which the company has given particular attention to the development of a high grade grader blade, during which time they have carried on extensive experiments and tests. In their search for a better blade stock, the company was guided by the one idea of maintaining a balance between wearing quality and price, or in other words, to find out by actual tests, what steel and what formula would produce the most miles of wear per dollar of blade cost.

According to the manufacturer, approximately 100 different specifications of steel or 1,000 samples were tested over a period of many months, these specimens including practically every known or used specification. The new formula high carbon manganese steel now used by the manufacturer was chosen as a result of this most exhaustive test. All Adams blades are now made of this new steel.

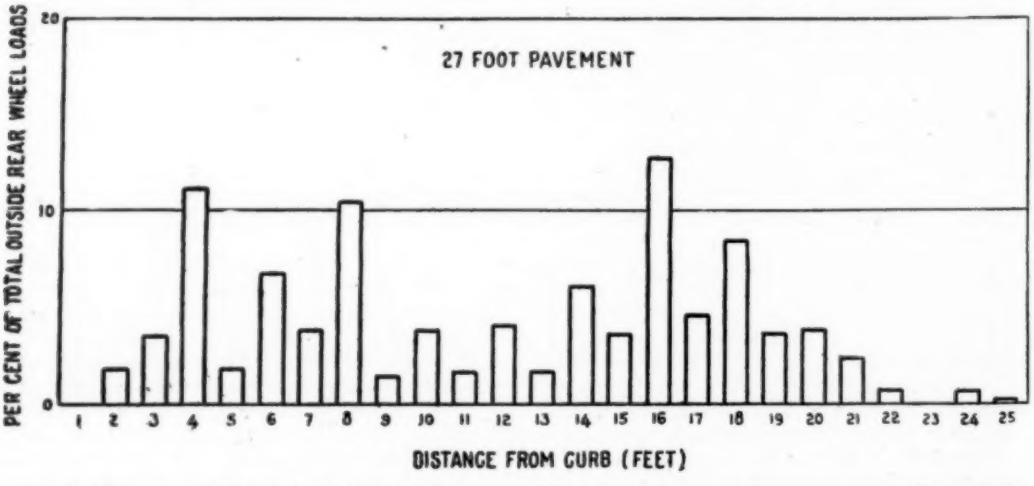

27 FOOT PAVEMENT
PER CENT OF TOTAL OUTSIDE REAR WHEEL LOADS
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
DISTANCE FROM CURB (FEET)

Fig. 3—Transverse Distribution of Motor Trucks on 27-ft. 1-way Pavement by Percentages of Total Number of Wheel Passages

Maintenance of Highway Right of Way

Methods in Kent County, Michigan, Described in Paper Presented Feb. 18 at 12th Annual Conference on Highway Engineering at the University of Michigan

By O. S. HESS

Managing Engineer, Road Commissioners of Kent County

For the purposes of this subject let us consider that maintenance of right of way covers all of the work incidental to the proper maintenance of Michigan highways, except the work of snow removal and other activities necessary to the adequate maintenance of the road surface or wearing course.

Let us then proceed to outline the various kinds of work which properly come within the scope of this subject, after which we may go into the details of just how this work is being done, using the methods followed in Kent County as a guide. The various subdivisions of maintenance referred to include the following:

Guard Rail Maintenance.
Shoulders and Washouts.
Care of Drainage Structures and Side Ditches.
Maintenance of Markers and Signs.
Cutting of Weeds and Brush.
Forestry and Landscape Work.

There are a number of other items of maintenance work which could be included in this list but as they are more or less special cases and not of general interest, we shall stick to the six subdivisions just referred to as far as this paper is concerned. A study of the past four years' maintenance costs of Kent County shows that these six subdivisions of work make up about 30 per cent of the total maintenance cost. Incidentally it is worthy of mention that the cost of a majority of this work is a fairly constant factor, not greatly affected by the type of road surface or the volume of traffic.

Guard Rail Maintenance.—The maintenance and proper care of guard rails consists mainly in rebuilding broken sections from time to time and in painting frequently enough so that they are plainly visible at night. Broken portions of guard rails should be rebuilt and painted as soon as possible after the damage has been done. In order to do this economically it is necessary to keep a supply of guard rail posts, lumber, cable and fittings on hand at all times. It is usually advisable to buy the posts and lumber in carload lots. If the repair work is on roads which are maintained by truck patrols, the material can be taken out to the desired points by the scraper men. The men who do the repair work can then drive an ordinary passenger car from place to place as they make the necessary repairs, thus saving the cost of operating a separate truck for this work. In other cases a guard rail repair crew of about two men, equipped with a light truck, can handle this kind of work very nicely, and carry all of their materials with them.

The manner in which guard rail painting should be handled depends largely upon the quantity of guard rail to be painted. If the quantity is small, it is only necessary to send out a couple of men with a light car carrying their supplies with them and doing the painting by hand. For larger quantities of guard rail, a spray machine should be used. Proper equipment for this work would consist of a 1 or 1½ ton truck with platform body on which would be mounted a small engine and air compressor outfit of sufficient size to operate two lines of hose. The paint tank should hold about 5 gals., this being a convenient quantity of paint to mix at one time. The best outfit is one with the engine, compressor and paint tank all compactly mounted on a small 4-wheeled truck. This kind of an outfit can be quickly removed from the motor truck, thereby releasing the truck for other work when rainy weather or other conditions make it inadvisable to paint guard rails. The paint crew should consist of two men, one to drive the truck and paint the inside of the guard rails, the other to work on the outside of the guard rail continuously.

A crew and equipment like this can paint nearly a mile of wooden guard rails in a day at a total cost slightly over 1 cent per lineal foot, including paint. In order to do this it is necessary to buy a first class lead and oil paint, such as would comply with the present Michigan Specifications for guard rail paint.

As a rule guard rails along gravel or dirt roads which carry a fairly heavy traffic should be painted every year. On paved roads, or other types which are not dusty, it is usually sufficient to paint them once in two years.

Shoulders and Washouts.—The work involved in maintaining the shoulders of the

road and taking care of washouts is in most cases a matter of hauling dirt or other material and placing it in V-shaped depressions which have been caused by the action of water. Some of our more heavily traveled paved roads, however, present greater difficulties. For instance, some of the old 16 ft. concrete roads which are now carrying 4,000 or more vehicles per day are handling quite a volume of traffic on the shoulders. It is sometimes necessary in cases like these to use large quantities of gravel on the shoulders and to install a regular patrol system of maintenance to keep it smooth. For the purposes of this paper, however, let us consider shoulder maintenance as being in the class first mentioned, assuming that the latter type of work should be charged to the surface or wearing course.

For reasons of safety and convenience it is very important that shoulders be maintained at all times in a condition fit to be traveled upon. To obtain this result, it is necessary that the maintenance organization be prepared to go out on short notice during and following storms with the proper men and equipment to take care of this work. At such emergency times men should be sent out ahead of the regular maintenance crews to put up lanterns, red flags, barricades, etc., to warn traffic of the dangerous places. Ordinarily, the crew or unit to do the work consists of a motor truck and two or three men. The number of units sent out depends entirely upon the volume of work to be done. These crews obtain dirt or other material as close to the washouts as convenient and dump it into the holes, smoothing it up with hand shovels so as to leave the shoulders and grade in good condition again. Sometimes the side ditches are eroded so badly that something must be done to prevent further washing. This can be taken care of in a number of ways; namely, by placing stone, rip-rap, cobble gutters, sod or brush. It has been the experience of the writer that brush, properly placed, is about the most economical and effective method in most cases. Washouts in the backslopes of cuts can usually be prepared against further erosion by cutting ditches along the tops of the slopes and parallel to the centerline of the highway which will lead surface water away from the points which have been giving trouble.

Washouts on the shoulders can be greatly reduced by keeping the shoulders a little low for some distance each side of the low points in grades, thus permitting the water to run off at many points instead of collecting at one place and tearing out a large hole. Sometimes it is advisable to follow an entirely different plan where we have deep valleys with steep grades leading into them from both ways, especially if the shoulders are built of sand or other unstable material. In these cases the shoulders should be kept a little high so as to lead all of the water to the low points, and at such points there should be constructed wooden or concrete chutes or possibly catch basins to take the water away from the road without damage to the shoulders. These are only a few of the more common methods of handling this kind of work. Each heavy storm, however, presents many and varied new problems which give the maintenance superintendent a splendid opportunity to use his ingenuity.

Care of Drainage Structures and Side Ditches.—It is obvious to anyone that the proper care and maintenance of drainage structures, especially under heavily traveled roads is of paramount importance. The highways of practically any county contain culverts of all types and sizes. It is necessary then that we have available culvert materials of many different kinds and men with the right equipment and knowledge to handle them. In the case of concrete culverts which are failing, for one reason or another, it is often possible to prolong or delay the failure many years by bolstering up the present structure in a rather inexpensive manner. The exact work to be done is usually different for each case, and must be determined by the man in charge. For this work, as well as for concrete culverts which must be replaced by new ones, we must have equipment for mixing and placing concrete in comparatively small quantities. This calls for a truck equipped with a dump body for hauling materials and a concrete mixer of about 1 sack capacity. The mixer and engine to run it should be mounted on wheels so that it can be easily loaded onto the motor truck, and quickly transported from one job to another. The crew generally consists of a foreman, truck driver, carpenter, and two or more laborers. A crew of this sort can build headwalls, repair old concrete culverts and build new culverts up to about 12 or 15 foot spans. It is the belief of the writer that replacement jobs much larger than these can be more economically handled by contract, after having received competitive bids. On all concrete work which is being handled by maintenance crews, the same rigid inspection of materials and workmanship should be furnished by the engineering department as is usually furnished on contract work of a similar nature.

For failures in culverts of sizes up to 36 in. and in some cases larger the replacement may be of encased tile, reinforced concrete pipe, corrugated metal or cast iron. If only a portion of the culvert has to be replaced, it is generally best to replace with the same material as the balance of the culvert. If the whole culvert has failed it is usually better to re-

place with something besides encased tile, as this type does not lend itself to maintenance work as well as one of the other types which can be placed without the use of concrete mixed on the job. It is also recommended that all driveway culverts be constructed without concrete headwalls. Field stone, laid up dry, around the ends is much less expensive, equally as satisfactory and better looking. Without concrete headwalls these culverts can be moved, lengthened or repaired without any loss of salvaged material.

In all of this culvert repair or replacement work it is important that the work be done with the least possible interruption to traffic. The circular culverts can usually be placed under a half of the road at a time leaving the other half for traffic. The concrete culvert jobs, however, present a more difficult problem. Generally it is necessary to construct a temporary bridge or by-pass to carry traffic. The character of the detour constructed or the amount of money spent on it, is largely dependent upon the volume of traffic which the road carries. It goes without saying that in all cases it is imperative that the proper attention be given to the correct use of signs, lights, barricades, etc., to warn and direct traffic.

No matter how well the drainage structures are maintained they cannot furnish satisfactory drainage service without the proper attention to inlets, outlets, and side ditches so as to allow the free flow of water. As soon as possible after the snow has left in the spring, men should be sent out on all of the roads with definite instructions as to where and what to do to properly take care of this phase of the work. About all the men need is transportation facilities, shovels to work with and proper instructions. This same plan should be followed out again in the fall just before freezing weather. Sufficient attention to this part of the work will save many times its cost later on in other branches of the maintenance problem.

Maintenance of Markers and Signs.—During the past few years a fairly complete system of markers and signs has been installed on the state trunk line system of Michigan. Many of the counties have followed suit and now have a complete signing system on their county roads. Without adequate maintenance, however, such a signing system becomes almost worthless in two or three years. As the plan of caring for these signs must necessarily vary a great deal under different conditions I will proceed to outline the methods followed in Kent County and leave you to draw your own conclusions as to how it should be done elsewhere.

To begin with, the maintenance superintendent is assisted by four district superintendents. Each district superintendent is provided with a car and required to look after all maintenance work in his district, which, in each case, comprises about one-fourth of the county and includes 110 to 115 miles of county and state trunk line roads. He covers all of the roads in his district nearly every day, and at least two or three times a week he has occasion to visit the main plant in Grand Rapids.

The signs themselves are just naturally divided into two classes. We have the danger and warning signs, which are made of cast iron, and the distance and direction signs, which are stamped metal plates fastened with brass screws to a board back. Both classes of signs are fastened to cedar posts. The cast iron signs are rather expensive and it is therefore necessary to repaint them every year or two in order to keep them looking good. The plates for the other class of signs are comparatively inexpensive, however, and it is found to be more economical to buy new plates than to repaint the old ones. This condition has resulted in the county maintaining a small stock of both classes of signs on hand at all times.

As the district superintendent goes about his work he makes a note of any signs which are in need of replacement or repainting. In a day or two, when he is at the main plant in Grand Rapids, he procures from the stockroom the particular signs he wants. The plates which he receives are new ones and the cast iron signs are probably repainted ones. He carries these signs along in his car, and whenever he comes to one of the poor signs out on the road, the old sign is simply replaced by a new or repainted one, and the old sign taken along back. The old plates are thrown away and the old cast iron signs are taken back to the stockroom on the next trip in. Whenever a sufficient number of the danger and warning signs have accummulated at the stockroom, a sign painter is set to work repainting them and then they are again placed back in stock to wait for another trip out. This plan of handling the sign job has worked out quite successfully in Kent County and undoubtedly has some distinct advantages for a county organization. First, there is no lapse of time when a post is without a complete sign. Second, the work of replacing and transporting the signs does not require special trips by anyone, and is therefore economical. Third, the repainting of old signs is accomplished under more favorable conditions with more speed and better quality of work. Fourth, the weather is not a factor to be reckoned with as is the case where signs are painted out on the road.

Although this plan of handling sign work is apparently very economical, economy is not

its greatest asset. The chief advantage lies in the fact that the signing system does not have to wait for a general overhauling but is taken care of promptly and continuously, maintaining a complete and good looking system of markers and signs at all times.

Cutting of Weeds and Brush.—Only a few years ago it was the exception rather than the rule to find a road with clean looking shoulders and the roadside free from noxious weeds and brush. Today we find a different landscape. The county which does not take care of its roadsides is considered to be negligent in its duties and a back number in highway maintenance work. In order to obtain the maximum use and safety of the highway it is absolutely essential that the shoulders be mowed frequently. To prevent the spread of noxious weeds and to keep the highway looking right, it is necessary that the right-of-way outside of the shoulders be taken care of.

The shoulders should be mowed at least three times during the season. A good time to start this work in this part of Michigan is about the last week in June. All of this shoulder mowing, the first time over, should be completed in about two weeks, and the organization and equipment should be worked out accordingly. About a month later, the shoulders should be gone over again. The third and last mowing should be done about the last of August or the first of September. These dates are of course only approximate, as they would naturally vary with seasonal variations. The number of mowings are about right, however, for most roads in this part of the state. This work has quite generally been handled with teams and ordinary mowing machines. In a few places Fordson tractors with mower attachments have been used. Both methods are satisfactory.

The right-of-way between the shoulders and the fences is usually of such a nature that mowing machines cannot be used, and consequently the mowing must be done by hand. There is no great haste about this work, and it is ordinarily satisfactory to start about the first of July and finish about the last of August. One mowing is sufficient, and it is not necessary to cut the grass. As a matter of fact, it is probably better to cut only the weeds, leaving the grass to go to seed. If this method is followed a few years will usually see the roadsides well sodded over with practically all of the weeds crowded out. Incidentally, this plan of mowing will probably cost less than half as much as the cost of mowing the roadsides clean, grass and all.

There is not much choice as to the manner of handling this work. The usual and probably the best plan is to place a sufficient number of men out on the roads with scythes to complete the job in the time required. Men can ordinarily be obtained at laborer's wages to do this work and furnish their own transportation.

Forestry and Landscape Work.—A phase of our highway maintenance work which has not received the attention it deserves is that pertaining to the beautification of our roadsides. In this state, which we boastfully call the "Playground of a Nation," we are year after year passing up one of our greatest opportunities. And that is the opportunity to make our roads attractive to the outsiders, as well as ourselves, by properly caring for what nature has already placed on them in the way of beautiful trees and shrubs, and by planting more in the barren stretches. The satisfaction which we, ourselves, can get from our own beautiful and well kept highways should be sufficient cause for action along this line, especially when we consider the low cost of the work, but when we find, as we already have found, that in this state it will pay out in dollars and cents, there should be no hesitancy in going ahead on a conservative and sound policy of this so-called beautification work. It is important that we keep our roadsides, as well as the traveled portions of the roads, attractive in appearance as it is the beauty of our state which attracts visitors and tourists.

Only a few of the counties in the state have gone into this sort of work to any great extent. Kent County has been one of the pioneers, having employed a forester and carried on roadside beautification work since the summer of 1921. At the beginning of the work it was decided that the first and most important thing to do was to properly care for the existing trees and shrubs before going into any extended tree planting program. The years which have gone by have shown the wisdom of this plan. The roads of Kent County can now speak for themselves as to the results accomplished. In starting out on a tree planting program, it must be remembered that no results can be expected from the standpoint of the looks of the highway in less than about 10 years time. On the other hand the proper trimming and care of existing trees and shrubs give immediate results. Of course, if funds are available for both kinds of work so much the better, but as a rule this not the case at the beginning of the work. In the construction of new roads it has been necessary to remove but a comparatively few trees or shrubs of any ornamental value. Only such trees that interfere with the actual construction work or with traffic are removed. The trees or shrubs which add any beauty to the road or surrounding landscape have been saved where possible and in some places changes have been made in the alignment of the road to avoid the destruction of groups of trees.

The policy of the Kent County Road Commission has been to keep all roads open to traffic throughout the year, and it has, therefore, been necessary to cut shrubs or groups of shrubs which cause drifting of snow upon the highway. While this has been found necessary in some instances, it has been found that in numerous other places the shrubs or groups of shrubs actually prevent snow from drifting by acting as a windbreak. In the case of newly constructed roads they are all thoroughly gone over by the forester and his trimming crews immediately after the road has been accepted from the contractor.

Kent County is unusually fortunate in having a great number of large beautiful trees along practically all of its highways. These trees, many of which were planted by the old settlers, were very often neglected after planting and as a result when the work of preserving these trees and shrubs was started they were badly in need of care. At the present time the entire mileage of state trunk lines and county roads on the Kent County Road system has been trimmed at least once and about 75 per cent of the mileage has been gone over the second time with the result that all of the highways so taken care of now present a very marked improvement in appearance. The improvement, however, is much more noticeable as time goes on than it is just after the first trimming has been done as the trees and shrubs, after trimming, often take on new life and present a more thrifty and healthy appearance.

The trimming work which has been done has consisted in the cutting out of dead, diseased, and superfluous branches, removing dead trees and shrubs, cutting off low hanging branches which obstruct traffic or corner views, and properly pruning and thinning all existing small trees and shrubs found on the right-of-way. All road intersections and corners have been cleaned out and cleared of all obstructions, giving the motorist sufficient view to prevent accidents. It is interesting to note that during the past year in Kent County no accidents have been reported due to obstructions at road intersections, corners, and railway crossings. This situation has never existed previous to 1925 and as there has not been a general decrease in the number of accidents we can safely draw the conclusion that the work of cleaning out corners, etc., is directly responsible for the elimination of accidents at the points referred to.

In the development and preservation of our roadsides it has been necessary to ask the co-operation of pole using companies. The manner in which they have co-operated with us during the past four years has been very satisfactory. They have spent large sums of money in re-building and re-locating pole lines at our request so that at the present time their interests conflict with ours in very few instances. On all roads which have 100 ft. right-of-ways there is room for trees and shrubs as well as for pole lines. In locating pole lines on right-of-ways of 66 ft. there is no hard and fast rule to follow as this width of roadway is too narrow for use of pole lines without some interference of trees. The lines must, therefore, be located where they will interfere the least with the trees and at the same time be safe for traffic.

Due to the fact that it has been deemed more important to maintain the trees and shrubs we already have, not much planting has been done as yet although several small stretches of roadsides have been planted. In planting a roadside it is well to keep in mind to plant the proper species of trees. This can be best determined by observing what species of trees thrive best in the direct vicinty in which the planting is to be done. For handling this trimming work our forester has been furnished with a 1½ ton truck and the necessary tools which he needs in his work. While this truck is light enough to get to and from the work quickly it is also heavy enough to transport all the tools and the required number of men. A crew of 6 to 8 men with the equipment just referred to works steadily on the trimming of trees and shrubs from spring to late fall. The work of cleaning out corners and intersections is usually handled by one or two men working separately and traveling from one place to another in their own cars.

Since June, 1921, Kent County has spent for all purposes in connection with forestry and landscape work along the highways a total of $27,000. This cost has trimmed 450 miles of roads once and about 300 miles the second time. It also covers the cost of cleaning out corners and intersections and the establishment of a number of wells in miniature parks at a number of points along the highways. Some of these little parks, which were established on corners where excess right-of-way had been purchased, are now very good to look at and help to relieve the sameness and monotony of many of our highways. The cost of trimming this 450 mile road system the first time over averages approximately $40 per mile. The re-trimming work costs about $5 per mile. It has been planned to go over the entire country road system from now on every year and do the necessary trimming and other forestry work which shows up from year to year. It is estimated that this work will cost $5 per mile or less per year.

Subway at Los Angeles, Calif.—A 2-mile subway, costing $13,500,000 for construction, will soon be started at Los Angeles.

Stone Road Construction

Method of Building 10 Ft. Light Traffic Roads in Jasper County, Indiana, Described in Paper at Recent Road School, Purdue University

By E. D. NESBIT
County Engineer, Jasper County, Indiana

During more than 10 years of being in charge of stone road construction in Jasper County, we have made some rather radical changes in our standard specifications, especially with regard to the size of stone and the manner of placing.

In making such changes we have kept in mind, First, the original cost to the tax payer; second, the cost of maintenance; and third, the service to be rendered, that is, the amount and weight of traffic.

Jasper County has been very fortunate in having their heavy duty roads taken over by the state, thus leaving the 460 odd miles of county roads subject to moderate to light traffic.

Staking Out the Work.—Before the work of construction is begun the centerline of the road is marked by stakes set along the margin of the road at 500 ft. intervals and plainly marked with the number of feet to the center of the road. These centerline stakes are set from corner stones or other controlling marks which must conform to the lines as determined at the time of the original survey and cross-sectioning. Station stakes are also set along the margin of the road showing the location of each station. Grade stakes are also set on both sides of the road at each station. The grade stakes are driven so the top of the stakes are flush with the finished grade in the fills and in the cuts they are left above grade and the cuts plainly marked thereon.

Grading and Draining.—After the stakes are placed, the first part of the construction necessary is the clearing and grubbing. However, I will not go into detail on clearing and grubbing as it is pretty well understood what the requirements are to make way for a good roadbed. Then comes the work of building the grade, cutting the side ditches and placing all cross drain pipes and concrete headers.

In building the grade, proper allowance shall be made for any and all settling and shrinking. Care must be taken to have the finished grade conform closely to the lines and cross-sections shown on the profile.

It is extremely important to so construct the side ditches that they will drain the road wherever it is possible to obtain an outlet. Also tile drains are provided for on each side of the road wherever a sufficient outlet is obtainable. We have found that the most successful method of eliminating so-called "quicksand pockets" is by the proper placing of drain tile.

All cross drain pipes are specified of corrugated metal and conforms to the state specifications on corrugated metal pipe.

Material.—Here is a paragraph taken out from standard specifications on "Material."

The material for the improvement shall be of crushed limestone and of the best quality obtainable and in all cases the stone must be of hard and compact textures of uniform grain. The stone must be of cubical form, broken, crusher-run stone and shall have a French coefficient of wear of not less than five (5) and to pass through a ring not greater than one inch in diameter. The stone is to be tough, strong, and uniform in color. No soft spongy stone will be allowed on the improvement.

Whenever any portion of the grade of the road, not less than 500 ft. in length shall have been completed to the satisfaction of the engineer, he shall give permission to place macadam upon such portions of the grade as in his judgment seems best. There shall be spread a layer of crusher-run limestone of not less than 10 in. in depth and 10 ft. in width requiring not less than 30.36 cu. yds. of limestone per each 100 lin. ft.

The finished surface of the macadam, 10 ft. in width shall have a crown of 3 in. and be of the form of a parabolic curve. All material shall receive a backing of earth along the outer edge to hold it in position.

The grade boards shall be set on both sides of the macadam in advance of the dumping and are not to be removed until backing and levelling up flush with the top of the same is complete.

In the foregoing paragraphs there is nothing mentioned about rolling the subgrade or the stone.

Ten years ago we included extensive and rigid specifications concerning the rolling of subgrade and stone, and a lot of money was spent for rolling. But close inspection has been kept upon these roads that were built of 2½ in. stone base and rolled, and the maintenance has been high compared with the road built with 1 in. crusher-run stone.

We have observed and decided without a doubt that in placing the money we used for rolling into additional stone and drain tile that we are getting much more for every dollar spent.

To give you some idea of the cost per mile under the foregoing specifications, I have taken the contract price on the last ten roads built in Jasper County and the average contract price is $5,311 per mile.

Metropolitan Traffic Control

A Discussion of the Various Methods Given in a Paper Presented April 30 at Annual Meeting of National Highway Traffic Association

By HAROLD M. LEWIS

Executive Engineer, Regional Plan of New York and Its Environs, New York City

The increase in vehicular traffic to a point far beyond what could possibly have been foreseen when the street systems of our principal cities were laid down has led to unavoidable congestion. As soon as this resulted in ecoomic loss from both accidents and delays some type of regulation seemed imperative; this first consisted merely in the establishment and enforcement of certain rules for the movement of traffic on those business streets where the concentration of vehicles was greatest. As the police department was already on the job in such localities and it was its duty to look out for the safety of the citizens, most of the responsibility fell upon police officials.

From an incidental duty the work of the traffic police has increased in importance until it has reached very large proportions and consumes the time and energy of a large percentage of any metropolitan police force. Without this type of regulation traffic would, long ago, have been at a standstill in our business districts. You can see proof of this by watching the confusion that arises at a busy corner without automatic signals when the traffic officer is temporarily called from his post. At the present time congestion and delays have extended over far greater areas. Long lines of slow moving vehicles are now found not only in the principal business districts but far out upon the main avenues leading to and from metropolitan centers. Local treatment, in many cases has only made possible greater concentration and still more serious difficulties. It has, therefore, become necessary to treat this problem on a broader scale. Traffic must be controlled not only by the regulation of its movement at certain points or throughout certain avenues by a co-ordinated system of control over considerable areas, proper planning and provision of new facilities, specified directions for routing, and classification and separation into various types of vehicles and those traveling at different speeds.

Regulation of Traffic Movement.—The fundamental principle of all regulations for traffic movement is the desire to secure the maximum use of present facilities. Many of our main avenues today are carrying far less than their possible capacity but are, nevertheless, choked with traffic that is able to maintain average speeds only equal to and in some cases less than, that which can be maintained by pedestrians. The reason for this is that it is not possible to obtain continuous movement. What is needed is not so much a greater maximum speed but more continuous movement to maintain a greater average speed.

The original tower system of traffic control, under which traffic throughout an avenue is halted at certain times and allowed to move at other times, has been described by J. Rowland Bibbins as similar in effect to a many bladed meat chopper descending on the city periodically and halting all movement at right angles to its blades. A progressive system of traffic signals, under which the signals permitting motion would advance along the avenue at such a speed as might be maintained by a moving vehicle, would permit continuous movement for through traffic traversing the entire length of the avenue. Instead of the effect of a meat chopper we would then have a condition such as might be described by the effect of a series of combs being drawn continuously across the city and pulling the traffic with them from one edge to another of the district under control.

Considerable progress has been made in several places toward developing and installing this latter type of traffic control. Mr. E. P. Goodrich referred to it several years ago as a "platoon system" and worked out a theoretical scheme by which traffic on the cross-streets could also move continuously, passing through the gaps left by the platoons of vehicles moving in each direction upon the avenues. With one-way streets and a uniform layout of blocks the application of such a system would be simple. With two-way movement upon the streets and varying block widths the problem is not so easy but the advantages of continuous movement are so great and so obvious that it is well worth careful study.

Synchronized Light Control at Washington.—The city of Washington has recently installed automatic synchronized light control on some of their principal avenues. Three lights are used—green for motion, red for stop and amber for an intermediate caution signal during which pedestrians only can cross an intersection. This system has been designed

so that alternate lights always show the same signal and they are timed so that the signals would change progressively along the avenue at intervals corresponding to a velocity along the avenue of approximately 22 miles per hour, which is the speed limit in residential sections. I am advised that it is practically impossible to keep up with these signals so as to move continuously throughout the avenue under control without traveling at times at a speed in excess of 22 miles per hour. This is due to the time required for acceleration when entering the avenue or passing other vehicles and to some irregularity in the distances between signals because of varying block lengths. It appears, therefore, that such a system of signals should be synchronized for a velocity a few miles less than the legal limit in the city under consideration.

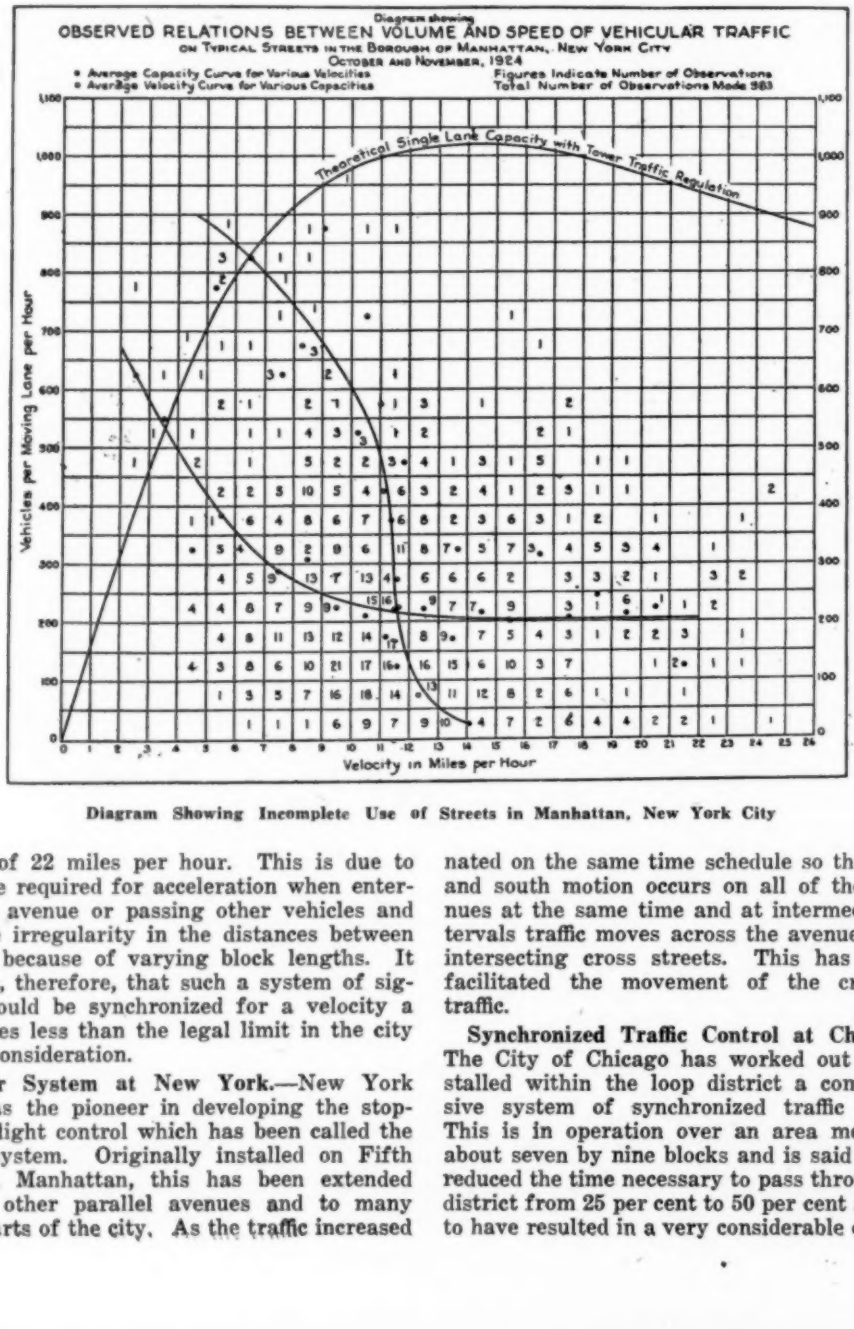


Diagram showing
OBSERVED RELATIONS BETWEEN VOLUME AND SPEED OF VEHICULAR TRAFFIC
ON TYPICAL STREETS IN THE BOROUGH OF MANHATTAN, NEW YORK CITY
OCTOBER AND NOVEMBER, 1924
• Average Capacity Curve for Various Velocities
• Average Velocity Curve for Various Capacities
Figures Indicate Number of Observations
Total Number of Observations Made 383
Theoretical Single Lane Capacity with Tower Traffic Regulation
Vehicles per Moving Lane per Hour
Velocity in Miles per Hour

Diagram Showing Incomplete Use of Streets in Manhattan, New York City

Tower System at New York.—New York City was the pioneer in developing the stop-and-go light control which has been called the tower system. Originally installed on Fifth Avenue, Manhattan, this has been extended to five other parallel avenues and to many other parts of the city. As the traffic increased in intensity the need arose for some co-ordinated treatment and the police department has installed a master tower at Lafayette and Canal Sts. from which bells are rung to indicate when lights should be changed at all the other control points on Lafayette, Fourth and Park Aves., which together furnish a single north and south route. Other master towers control signals on Broadway and Fifth, Sixth and Seventh Aves. and these are all co-ordinated on the same time schedule so that north and south motion occurs on all of these avenues at the same time and at intermediate intervals traffic moves across the avenues on all intersecting cross streets. This has greatly facilitated the movement of the crosstown traffic.

Synchronized Traffic Control at Chicago.—The City of Chicago has worked out and installed within the loop district a comprehensive system of synchronized traffic control. This is in operation over an area measuring about seven by nine blocks and is said to have reduced the time necessary to pass through this district from 25 per cent to 50 per cent and also to have resulted in a very considerable decrease

in traffic accidents. The details were worked out by a Committee of the Association of Commerce under the leadership of E. J. McIlraith, Staff Engineer of the Chicago Surface Lines. The method of operation has been described as follows by Mr. McIlraith.

"If we consider the movement on a sample north and south street under signal control there must be for such street, at the first cross street where the control is placed, a period permitting east and west traffic followed by a period permitting north and south movement. The vehicles are then admitted to the section under control in groups separated by the time interval allowed for the east and west movement.

These vehicles admitted in each group should be permitted to pass steadily along the street at the speed for which the system is set without having to stop for east and west movement at each cross street. The east and west movement would occur in the time interval that exists between the groups moving northbound or southbound, since this interval was established at the first cross street. The basis for the setting must be a very careful traffic analysis."

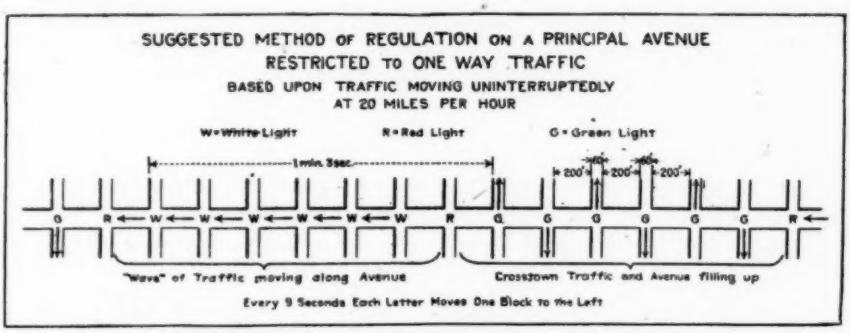
Mr. McIlraith has pointed out that this system may be used

"either for boulevard control, for business area control, or for residence districts, although it may not be possible to tie together a fast moving boulevard adjacent to a slow moving business district. Such two groupings of streets may have to be worked independently to get the best results."

He also states that a boulevard control system has been worked out which would permit vehicles to move continuously throughout about 2½ miles of Michigan Boulevard, maintaining a speed of 25 miles per hour for about half of this distance and 20 miles per hour for that remaining part which passes through the busiest section. The system now operated upon this Boulevard permits an average speed of only 11½ to 12 miles per hour.

Chicago thus furnishes a practical example of what may be done, but the loop district in that city is especially adapted to such a system as it is free from diagonal streets and the blocks are approximately square in shape. The system could not be arbitrarily copied by another community which would have to base its own system upon its own traffic analysis and a careful adaptation to local conditions.

There are other supplementary methods of regulating movement to improve traffic capacity. These include the restriction of time during which certain trucking operations can be carried out in the business districts, specified routing for trucks between certain concentration points, and consolidation of trucking operations to avoid a duplication of trips due to partly loaded vehicles.


SUGGESTED METHOD OF REGULATION ON A PRINCIPAL AVENUE
RESTRICTED TO ONE WAY TRAFFIC
BASED UPON TRAFFIC MOVING UNINTERRUPTEDLY
AT 20 MILES PER HOUR
W = White Light
R = Red Light
G = Green Light
1 min. 3 sec.
200'
200'
200'
"Wave" of Traffic moving along Avenue
Crosstown Traffic and Avenue filling up
Every 9 Seconds Each Letter Moves One Block to the Left

Suggested Method of Traffic Regulation on a Principal Avenue

The Parking Problem—The parking problem is a very serious one in many cities. Fundamentally it is probably illegal to occupy street space for standing vehicles even for loading and unloading purposes but it does not seem desirable to attempt to take away such rights which have long been exercised. It is obviously a public hardship, however, to permit the use of a great part of the street by standing vehicles which remain for hours while the owners occupy themselves in their offices or in other ways, or for almost continuous loading and unloading of commercial vehicles during the busy hours of the day. The first condition should be relieved by the erection of sufficient multiple story garages within walking distance of the main office and shopping district; the second should be remedied by regulations to compel the provision, by establishments which handle a large amount of trucking or passenger traffic, of loading and unloading spaces within their property lines. There are many cases where this has been done voluntarily to the great advantage and increased efficiency of business concerns.

Provision of Highway Facilities—Restrictions are fundamentally objectionable and when they interfere with liberty to do what would seem reasonable under normal conditions and thus become more than a restraint on propriety and wrong doing they are little more than palliatives. The only hope for a more constructive and permanent relief for traffic control must, therefore, be approached through the planning and provision of adequate physical facilities. This is an indirect method but in the long run a much more effective one. It

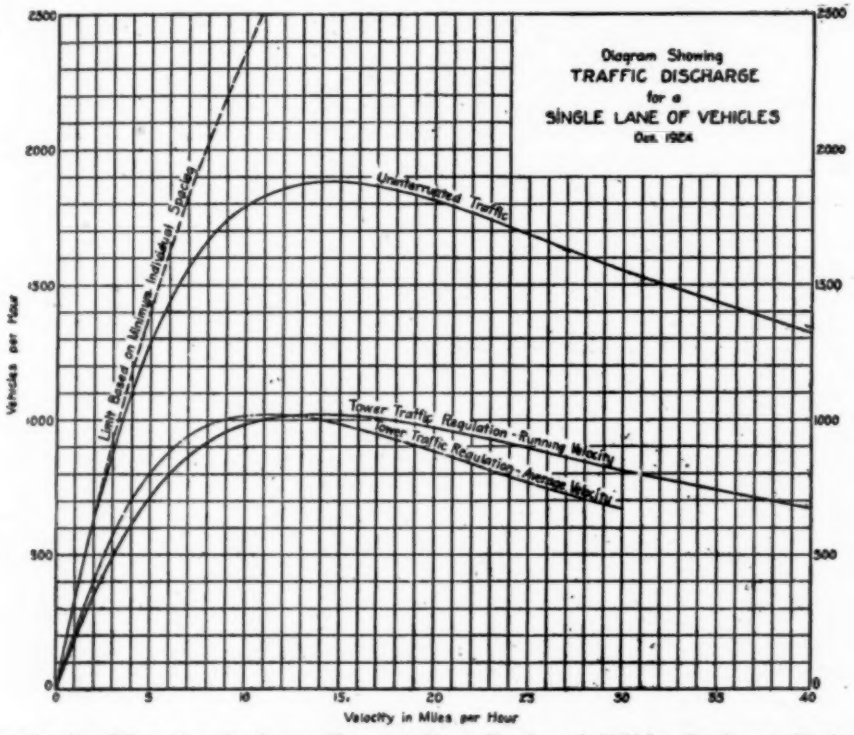


Diagram Showing Effect of a Continuous Movement Upon Number of Vehicles Passing a Fixed Point

does not require restrictive ordinances to be effective as economic laws will force traffic to choose the route best adapted to its demands. I refer to the provision of direct routes between main traffic centers and by-pass routes around those centers which will make it possible for through traffic to avoid congested business streets. New or widened facilities within the more intensively built-up areas can in many cases be provided only at prohibitive cost. New routes on the edges of such districts can be furnished much more readily. It may thus be found that the best relief for a particularly serious congestion point can be obtained not by changes in the immediate vicinity but by broad scale planning which might call for improvements at points many miles away. We have a very good example of this in New York City where much through traffic, which has no desire to come there, is forced to pass not only through Manhattan Island but through the busy streets and most densely built-up section of that island. Several projects have been proposed which will go far toward relieving this situation. These include the development of a motor vehicle speedway on the Hudson River waterfront of Manhattan, the provision of a new crosstown highway from Brooklyn to Queens which will enable vehicles to enter Manhattan nearer their points of destination and a proposed Hudson River Bridge between 179th Street, Manhattan, and Fort Lee, N. J., which would provide a by-pass route from New Jersey, and all points south, to New England and the Hudson River District.

Traffic Planning Organization—One of the most important things in connection with the solution of the traffic problem is the establishment of an agency to develop adequate plans and see that they are carried out. A governmental agency would have both of these functions, but if it is necessary to depend upon a non-official agency the latter can only make recommendations, depending upon the municipal officials to carry them out under the pressure of public opinion. The question of

what is a suitable agency was gone into very carefully by the Committee on Metropolitan Traffic Facilities of the National Conference on Street and Highway Safety which met in Washington, D. C., March 23rd to 25th of this year. The conference report adopted at that time included the following recommendation based upon the committee report referred to:

"In each city there should be an official traffic commission, including such officials as the chief of police, city engineer, engineer of the city plan commission, chief of the city fire department, a representative of the public authority supervising city transit and transportation, a member of the city council, and a representative of the city's legal department. This commission should be a permanent body having the services of an engineering staff, preferably in charge of a trained traffic engineer, and should prepare a comprehensive traffic plan, make and keep up to date a traffic survey, and recommend a traffic ordinance and regulations, or recommend from time to time any necessary modifications in the existing ordinance and regulations."

A traffic committee, representing various civic organizations and public and semi-public utility corporations, was also recommended as an advisory body.

City organizations would be sufficient where the city concerned is a relatively isolated one forming in itself a metropolitan center. Where two or more cities are so closely continguous that they form a single metropolitan community with a common traffic problem, a broader scale organization is necessary. The Conference report included the following recommendations to cover such a case:

"To provide unified consideration and treatment of traffic problems in metropolitan areas which include more than one city, or a city and politically independent suburbs, it will generally be necessary to depend upon an enlargement of the unofficial traffic committee of the central city by adding proper representatives of important suburban communities, or in the case of two large cities in a single metro-

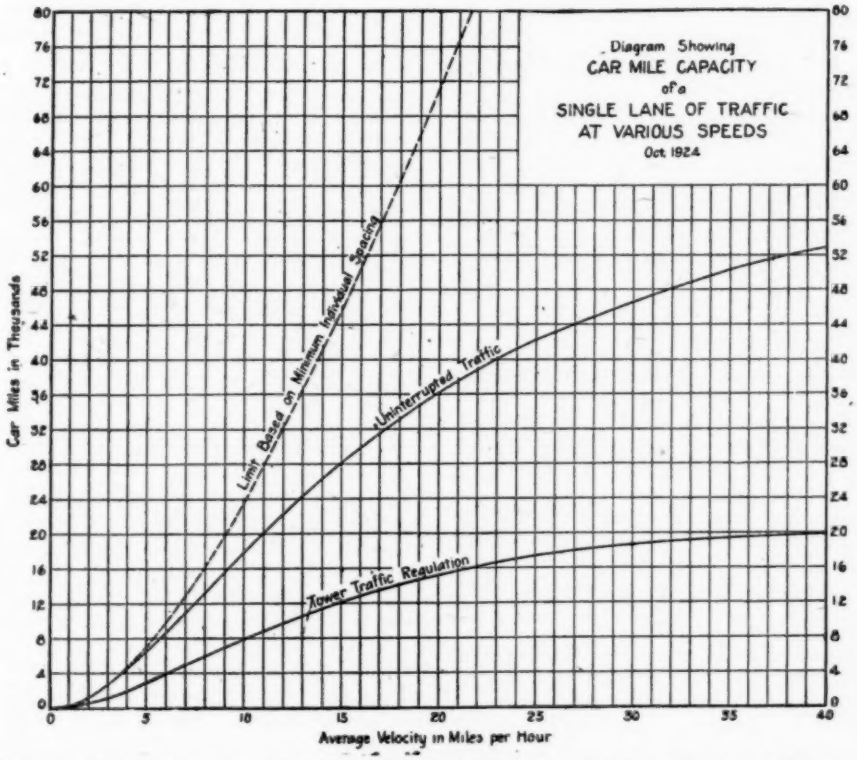


Diagram Showing Effect of Continuous Movement Upon Car Mile Capacity of a Highway

politan area, to form a joint traffic committee with representatives of suburban communities added. When developments warrant, an official metropolitan authority should be created to control physical growth and provide for proper traffic facilities within large population centers."

These recommendations are final conclusions reached by a representative gathering from all parts of the country and therefore bear great weight. They should go far toward assuring the setting up of efficient organizations to deal with this problem in our cities. There are some difficulties which have occurred to me, however, which I would like to bring to your attention.

The city traffic commission suggested would consist of seven members or perhaps a minimum of five members in small cities which had a simpler organization: It is specifically stated that it should be a permanent body, yet every one of its members would be subject to change under a shift in administration. In many of our cities the engineer members might enjoy a considerable degree of permanency but there is often no assurance of this.

Also, all the members would be extremely busy men whose present offices are of sufficient importance to demand practically all of their working time. Their positions are such that their advice would be invaluable in determining upon a traffic policy, but it should be recognized that they would be primarily an advisory body to the technical staff of the commission which must bear the main responsibility and should, therefore, be granted part of the authority.

I would suggest that the head of this technical staff, who the Washington Conference recommended should preferably be "a trained traffic engineer," should himself be the chairman of the traffic commission, perhaps with a title of traffic commissioner. If he, together with the city engineer and the chief of police, were designated as an executive committee of the larger commission, I believe that you might then have an efficient organization, which would not place an impracticable burden upon existing officials but would insure the effective co-operation of those whose advice would be most essential for developing and enforcing a suitable traffic program. It would be essential that the office of Traffic Commissioner should be non-political and continuing. Thus, with the possibility of the city engineer being continued over a change of administration, a sufficient degree of permanency would be assured for the executive committee of the traffic commission.

Where there is a comprehensive city plan commission it would seem logical that the traffic planning organization should be made a part of such a commission. This would seem especially desirable if it is admitted that the traffic problem is as much, if not more, one of proper planning of highway facilities as of regulation of traffic movement.

In the final analysis the determination of what shall be actually carried out must rest with the municipal executive body but, there is no doubt but that they would welcome the advice that they would obtain from a properly functioning traffic commission and would generally accept its recommendations.

In large metropolitan areas in several cities an unofficial traffic committee, as recommended by the Washington Conference, would probably have to be depended upon. Perhaps, as the importance of the traffic problem and the evils of the present growing congestion are more recognized, there will be a better opportunity for the establishment of unified authority over such areas. In regions such as New York City and its environs where there are over 400 different political units it would be very difficult to obtain political co-operation, particularly as the communities are located in three different states.

The Committee on Regional Plan of New York and its Environs is an unofficial committee which is studying the traffic problem within this Region as well as all other phases of regional planning. In this case the committee is considerably different from the unofficial committee suggested above as it was organized, and has up to this time been financed solely by a social service corporation, the Russell Sage Foundation. The personnel of the committee is not however confined to trustees of the Foundation, but includes other representative public-spirited business men and it has retained the best expert advice that was available. This type of committee has had some advantages, particularly that it has felt able to take a broad viewpoint of the entire situation and has been free from the danger of narrow local points of view which it would be almost impossible to avoid in a committee whose members were chosen from certain business groups or geographical subdivisions and who would unavoidably feel that their first duty was to look out for those special interests or communities which they represented. Such an organization can, however, only go as far as preparing and presenting the best plan which they may be able to conceive and some more permanent and representative body will be necessary to insure the carrying out of a proper program of development.

The Correlation of Transportation Facilities

Information on Expenditure by Motor Vehicles and Railways for Road Improvements Given in Paper Presented January 13 and 23rd Annual Convention of American Road Builders Association

By T. R. DAHL
Vice-President, White Motor Truck Co.

The history of the development of motor vehicle transportation is within the memory of this generation. You have seen it develop from a curiosity of a few years ago to a necessity of today. Very naturally, established transportation agencies evidenced no glee at the development of what appeared to them to be a serious competitor. Both steam and electric railway men had been taught from childhood that the ideal transportation was steel upon steel. What we are taught as children, regardless of what end the learning is applied to, becomes almost intuitive. The experience of these transportation men was limited to rails and naturally, they were not only not willing to change their ideas in a few short years, but probably were actually unable to do so.

The private passenger car made tremendous inroads into the passenger traffic of both steam and electric railways. There was, apparently, no manner in which the railways could protect themselves against this loss of traffic to individual transportation units. The growth of the motor bus and the motor truck, carrying people and freight for hire, offered a very different target. The result was an exact repetition of history with the shoe on the other foot, for when the railways were first established the same attack was made on them as a competing carrier by the stage coach, toll road and canal companies. Read the publicity of that day, simply changing the names of the carriers, and the picture might have been painted by the same artist.

Regulation of Motor Vehicles.—The motor vehicle industry through its National Association early realized that for its own protection it must not only support but actually initiate laws regulating the operation of trackless transportation vehicles. It appreciated that an extended highway program would require that motor vehicles should bear their proper share of taxation. It understood that when such motor vehicles began using the public highway for the conduct of its business that such use must be reasonably regulated. The result was that the day of the jitney bus was short. Legislation was enacted in practically every state regulating the operation of motor vehicles, taxing their use of the public highways and regulating the use of the public highways for the conduct of business. It is the use of the highways for business that brought this facility into conflict with other transportation agencies, principally the steam and electric railways. For some years attempts have been made to smother the commercial motor vehicle with regulations and to throttle it by taxation. It soon became apparent, however, that when representatives of these various transportation agencies got together they found they had a good deal in common and that more might be accomplished in cooperating in working out their mutual problems than by quarrelling with each other. The result has been that today the problem has largely narrowed itself down to this. What is the proper sphere of operation for the commercial vehicle? We don't flatter ourselves that all our problems are solved. We have, however, made progress. The National Automobile Chamber of Commerce, representing the motor vehicle industry, and the American Electric Railway Association, representing the electric railways, have subscribed to a mutually agreeable platform of principles regulating the use of motor vehicles as common carriers. The electric railways are primarily interested in the motor bus. The Committee known as "Committee Four" appointed by the U. S. Chamber of Commerce, comprised of a representative membership of railroad officials, motor industry officials, shippers and the public, after working some six months reported that the great sphere of operation of the motor trucks as related to steam railroads was in terminal work, store door delivery and in short-haul zones within which the motor truck is pre-eminently fitted for service. The motor vehicle industry is highly desirous of a closer contact with the steam railroads of the country in attempting to work out the detail of such operations. There are many problems which must be solved.

Some of the Problems That Must Be Solved.—A statement of a number of these problems is made by Mr. Chas. H. Markham, President of the Illinois Central Railway System in an article on Transportation appearing in the January 9, 1926, issue of "Liberty Magazine." Mr. Markham says this about the motor truck in this article:

"A question that needs to be considered is the growing public sentiment against the destruction by motor vehicles of public highways built wholly at public expense.

"The public is coming to realize that the taxpayers' money that is spent upon the construction and maintenance of public roadways is really a part of the cost of the service provided by motor vehicle carriers, just as the money spent on their roadways is a part of the cost of the service provided by the railways.

"The only difference at present is that the railroads pay for the construction and maintenance of public highways and have to charge rates to cover that expense, while taxpayers foot the bills for providing hard roads, and motor vehicle companies consequently do not have to include such costs in the rates they charge. As competitors they have an unfair advantage over the railroads.

"In determining the true economy of transportation by highway due consideration must be given to all items of cost, including the cost of suitable highways, however paid for.

"The operators of motor vehicle carriers have contributed comparatively little to the costs of providing these highways, but they are doing more than any other agency to wear them out."

Are highways built at the public expense?

Who is this public which pays for the highways?

What do steam railways pay toward highways?

Are motor trucks competitors of steam railways?

Motor Vehicles Share of Road Expenditures.—The answer to these questions lies in determining what part of road expenditures, if any, the motor vehicle pays in taxes. Taxes on motor vehicles during 1924 amounted to half the total highway bill of the nation. This bill, according to the figures of the Bureau of Public Roads of the U. S. Department of Agriculture, amounted to $1,181,000,000. Motor vehicle taxes amounted to $551,000,000. These taxes collected from motor vehicles equal 92 per cent of the expenditures for the State and Federal Road Systems, the highways which carry 80 per cent of the traffic. State license fees alone were more than twice the amount required for the up-keep of the State roads. Taxes collected by the Federal Government from motor vehicles has amounted to twice as much money as the Federal Government has expended for Federal aid on highways. The figures conclusively prove that the motor vehicle paid 42 per cent of the entire highway program of the country and actually paid 92 per cent of the cost of the highways which carry 80 per cent of the traffic. To say, therefore, that the highways were built wholly at public expense may immediately be corrected to the extent that 42 per cent at least was paid by the motor vehicle itself, and when it is considered that 80 per cent of its traffic is on Federal aid highways and main market systems of the State, and that the motor vehicle paid 92 per cent of the cost of such highways, it is more accurate to say that the motor vehicle paid somewhere near 90 per cent of the cost of the highways over which they operate. Considering again the entire bill for highways in this country, the 58 per cent of their cost which was not paid by motor vehicles was paid for out of bonds, federal aid, property taxes and general taxes on all business. Too many of you men have seen the increase in property values arising from the construction of improved highways and the service which such highways give to the public to necessitate any extended argument to prove to you that the public can well afford to pay a great deal more than 58 per cent of the cost of all highways for the benefits derived.

There are 20,000,000 motor vehicles in this country today, an average of one for almost every family. That astounding fact is better appreciated when one realized that there are actually more automobiles in this country today than there are telephones. Who but these same families owning motor vehicles pay the general taxes that are spent for the construction of highways? The motor vehicle owner is the largest single taxpayer toward general highway purposes over and above the 42 per cent of the highway bill which he pays in Special taxes.

What Do the Railways Pay.—The railroads complain very bitterly of paying a large part of the cost of highways for the use of a competitor—the motor vehicle. What part of the highway bill do they pay? In this same year of 1924 they paid $34,163,000 of the $1,181,000,000 highway bill, or exactly 3.6 per cent. What return do the railroads get for this 3.6 per cent of the highway bill that they pay? It is immediately evident that every ton of freight handled by the railroads, except such as is loaded at industrial sidings, must be carried both to and from the rail head over the highway. Providing a road bed for freight to and from the rail head is very cheap for the railroads at 3.6 per cent of the cost the revenue from motor products in the same year given to the railroads actually amounted

to over $400,000,000. This $400,000,000 is actually automotive freight revenue and does not include freight revenues on raw materials, coal, steel, etc., going into motor vehicle plants. Accordingly, if the entire highway bill of the steam railroads is charged against purely the automotive revenue, that tax bill is only 8½ per cent of the revenue derived from automotive products. I need not assure you that new business cannot be obtained by motor vehicle manufacturers for any percentage approaching a cost of 8½ per cent for that business.

I submit that no one, passenger car or truck operator, who annually pays a license fee for the right to use his car or truck and who regularly pays a gasoline tax of 2, 3 and 4 ct. a gallon in 44 states of the Union, every time he purchases gasoline, can be deluded into the belief that the use of the highway is free.

Alleged Advantage of Trucks Over Steam Railroads.—What are the facts concerning the alleged advantage which motor trucks have over steam railroads because, as alleged, they do not have to include in their hauling charge a payment for the construction and maintenance of public highways.

Private passenger cars, constituting 88 per cent of the motor vehicles using the highways, not being used in the carrying of freight must be left out of any computation as to the amount of charge per ton of carrying capacity that vehicles pay for the use of the highway. In confining the computation therefore to trucks, the U. S. Department of Agriculture surveys establish that the average license fees paid by all motor trucks in 1924 was $21.10 per truck. The percentages of the various sizes of trucks rated according to carrying capacity are as follows:

	Per cent
¾ ton and less	10.8
1 ton and less	71.4
1½ ton and less	7.7
2 ton and less	2.2
2½ ton and less	3.8
3½ ton and less	1.0
5 ton and less	1.8
Over 5 ton and less	1.3

making an average capacity of motor trucks in use of 1¼ tons. The average license fee per truck being $21.10, the fee per ton of carrying capacity is therefore $16.90. Compare these costs with railroad costs.

"According to the annual report of the Baltimore & Ohio Railroad Company for the calendar year 1924, that Company paid from its revenue during the year a total of $26,638,363.05 for maintenance of way and structures. The same report states that in the Company's equipment there were 100,092 freight cars and 1,441 passenger cars. Consider that the entire cost of maintenance of way and structures was paid by the freight business. Assuming then, that the capacity of 100,092 freight cars averaged 40 tons per car, we find that the draft upon the Company's revenues for maintenance of way and structures was only $6.65 per ton of freight car capacity, or more than $10.00 per ton less than the commercial motor trucks paid in license fees alone for the use of the highways."

According to the annual report of the Illinois Central System for 1924, the Company paid from its revenue during that year a total of $20,034,135 for maintenance of way and structures. The same report states that in the Company's equipment there were 69,523 freight cars and 1,646 passenger cars. If we charge the entire cost of maintenance of way and structures to the freight cars alone and again assuming an average of 40 tons per car, it is arithmetically determined that this Company's draft on its revenue for maintenance of way and structures was $7.03 per ton of freight car capacity or $9.87 per ton less than the commercial motor trucks paid in license fees alone for the use of the highways. In view of the fact that there are 44 states in the Union collecting a gasoline tax of from 1 ct. to 4 ct. per gallon on gasoline and these taxes are not included in this charge against motor trucks, it is immediately apparent that the motor truck pays a great deal more than twice as much per ton capacity for the use of the highways than the railroads pay per ton capacity for maintenance of way and structures. By way of example, in the state of Ohio the gasoline tax collections last year, under a 2 ct. gasoline tax law, exceeded the license tax collections. A fair estimate of what trucks paid therefore would be twice $16.90 or $33.80 as against practically $7.00 paid by the railroads for their maintenance. It is conservative, therefore, to say that the motor truck is today paying four times as much per ton capacity for the use of the highways as the railroad companies are paying per ton capacity of their freight cars for the maintenance of their way and structures. I therefore submit to you that instead of the motor truck having an advantage over the rail carriers, as far as the expense of the road over which he operates is concerned and thereby obtaining an unfair advantage over the railroads, that the railroads have an advantage over the motor trucks of something like 400 per cent on that one item alone.

The facts herein given and the figures quoted have been established by surveys of the Bureau of Public Roads of the U. S. Department of Agriculture which is the recognized authority on highways in this country. The Department has also established, through investigation, a very instructive comparison between the ratio of tax paid for the use of highways to the gross operating revenue of motor trucks as compared with the charges

of railroads for maintenance of ways and structures against their total operating incomes. Without going over the detailed figures of the computation—the details of which can either be obtained from the Bureau of Public Roads or will be found in an article by Thos. H. MacDonald, the Chief of that Bureau, printed in the October issue of the Journal of Land and Public Utility Economics —the conclusion reached is that motor trucks actually pay 10 per cent of their gross operating revenue for the use of the public highways, whereas the steam railroads over a 12 year period from 1911 to 1922 charged an average of 13.3 per cent of their total operating income for the maintenance of way and structures. When it is considered that motor trucks constitute only 12 per cent of the motor vehicles using the public highways, whereas the steam railroads use their right of way exclusively, it is apparent that the motor truck has no advantage over the steam railroad, but is actually at a disadvantage when considering the percentage of operating income which they must pay for the partial use of the public highway.

Use of Commercial Vehicles by Other Transportation Agencies.—No better proof of the place of the motor bus and truck in transportation could be offered than the use of such vehicles by the steam and electric railways today. The steam railways are using motor trucks in terminal work, interline hauls, replacing local trains by motor trucks, using rail cars, etc. Fifty-one railroad companies are today operating motor trucks. An excellent example of the terminal use of the motor truck is the 7-year experience in Cincinnati where all less than carload freight is handled by motor trucks between sub-stations in that City. An average of 2 days and 14 hours was required to move a freight car a few miles between stations. Now similar distances are covered in 14 minutes by 15 5-ton trucks which transfer freight from terminal to terminal. The trucks also tap the suburbs bringing in freight in ample time for daily distance shipment in bulk and saving anywhere from 1 to 14 days. This service releases in a year 66,000 box cars from trap work for profitable distance haulage. This cost is 80 cts. per ton as against $1.20 to $1.60 by previous methods.

Today the Pennsylvania and the New York Central Railroads are using the motor trucks in varied capacities to supplement existing facilities and to enable them to meet more efficiently the ever increasing demand for transportation. The Boston & Maine is installing a motor transport system to replace hundreds of miles of unprofitable rail operations. The New York, New Haven & Hartford is engaging in store door delivery. Scores of railroads are using gasoline rail cars to replace steam trains. The Great Northern Railroad is inaugurating a great bus system. The modern railroad man appreciates that he is in the business of furnishing transportation to the public and is using the motor truck and bus as an arm of that service.

The electric railways are themselves operating bus lines in a multiude of ways, feeders, cross-town lines paralleling their own tracks, and even replacing their entire street car systems in some cities with motor bus lines. Two hundred fifty electric railway companies are today operating 5,000 busses over 12,000 miles of route.

Interstate Commerce Regulation.—The motor vehicle industry subscribes to the regulation of motor busses as public utilities in the same manner as steam and electric railways are regulated. We believe that motor busses are quasi public corporations and should as such be regulated as monopolies. We believe this is true not only in intra-state operations but also in inter-state operations. We therefore favor the enaction by Congress of a law regulating such operation. We believe that such operations are primarily of local interest and concern and that therefore State Public Utility Commissions of the States through which the lines operate should actually regulate such operation so far as that power can constitutionally be delegated under the Commerce Clause of the Federal Constitution.

We believe the case of the motor truck presents an entirely different picture. The motor bus is essentially a monopoly, or probably more properly termed, a quasi public corporation. Where the only transportation offered is a motor bus line it is essential for the service to the public that such a facility be regulated by a public commission, both as to service and rates of fare. This is not at all true of the motor truck. A motor truck common carrier is subject to competition of both the motor truck contract carrier and the private trucker. The user of a common carrier truck line has therefore several options if he is dissatisfied with service or rates. He can employ a contract carrier or he can properly make a capital investment in his own business to purchase his own trucks to carry his freight. Motor trucks therefore, being subject to other motor truck competition do not partake of a public nature and are therefore not quasi public corporations or monopolies. Competition gives to the public the protection it needs without regulation by a political body and therefore motor trucking is in the same class as any other competitive business. In the manner of interstate operation there are a number of practical reasons why the motor truck should not be regulated by Congress, but one I believe is sufficient—only 1 per cent of the

motor trucks in operation in the country today are engaged as common carriers in interstate business.

What Transport Surveys Show.—The motor truck industry contends that it is not a competitor of the steam railroad and makes that contention because motor trucks are engaged principally in a service of distribution to and from railroads, in short hauls which are unprofitable to railroads and in the extension of transport service in the areas not served by railroad. This contention is not merely an opinion, but is based on actual facts as developed by the Bureau of Public Roads through surveys made in the various states in the Union. In Connecticut, for instance, it was found that 40 per cent of the total tonnage of motor trucks is moved less than 10 miles, and that nearly 70 per cent is moved less than 30 miles. In California 25 per cent of the total tonnage is hauled less than 10 miles and 60 per cent less than 30 miles, and the tonnage which is hauled more than 70 miles is less than 20 per cent. Here in Cook County 24 per cent of the movement is less than 10 miles, 75 per cent less than 30 miles and less than 3 per cent moves further than 100 miles. These percentages are based on actual surveys and that means actual traffic counts on the roads by observers for the Bureau of Public Roads. This service is distinctly a service of distribution from centers. It is a service which does not aim to move large bulk day after day between the same points. Within the short-haul limits it is taking some of this business away from the railroads and the railroads should be glad to see it go because they have lost money on it. In all of the cases investigated it is immediately apparent that the business which the motor truck is doing is limited to a short-haul movement. The Bureau of Public Road figures, based on their surveys, prove therefore that the motor truck is not a competitor in any volume of freight with the steam railroad except only in very short-haul movement, and if it is true, as has been repeatedly stated by the Presidents of our largest railroads, that the short-haul business is unprofitable, then the motor truck has relieved the steam railroads of unprofitable use of its freight cars for long haul profitable freight. In addition it has placed in the hands of the railroads and auxiliary means of transportation whereby it itself can more economically handle its less than carload freight and effect tremendous economies in relieving its terminal congestion. These contentions are also supported by experience and you have but to examine the use made of motor trucks by the Pennsylvania and New York Central Railroads in the handling of local less than carload freight, and the terminal operations of the Cincinnati Motor Terminals Company, to convince you of the tremendous economies and facilitated service which the railroads can obtain through the use of the motor truck in these capacities. There are now 51 railroads using motor trucks as part of their service compared with 33 a year ago.

Motor competition is not the cause of track mileage abandoned by the railways. Since 1916 the railways have abandoned more than 3,800 miles of track. The reason ascribed by the railways themselves, as appears in the records of the Interstate Commerce Commission as required by the Transportation Act of 1920, is that 58 per cent was abandoned on account of the exhaustion of natural resources, 30 per cent through competition by other railways, 1.3 per cent due to rearrangement of lines, 7.3 per cent from miscellaneous causes and but 4.3 per cent because of highway competition.

The conclusion is inevitable, that the facts as determined by experience, investigation and surveys establish:

First, that the motor vehicle and particularly the motor truck pays its full quota of taxes for the use of the public highways.

Second, that the motor truck has no advantage over any other carrier because of its use of the public highways because it not only pays more per ton of capacity in taxes for the use of its road bed than the railways charge per ton of capacity for maintenance of way and structures, but also pays approximately the same percentage of its operating income in taxes for highway use as the railroads charge for maintenance of way and structures.

Third, the motor truck is not a competitor of the railways except in short-haul less than carload lot movements which railway companies themselves admit is unprofitable business.

The greatest problem in this country is the problem of distribution. Economists admit that today, on the average, it costs more to distribute than it does to produce. We are living in a mechanical age in which quantity machine production has pared to the bone production costs. If there is to be any further material reduction of living costs in this country it must be in the reduction of the distribution part of the cost of merchandise and products. Produce is transported over the highway from the farm, the forest, the mine and the factory, from wholesale to retail stores and from store to consumer, four, five and even ten times to the once or twice it is shipped by rail or water. Here is the part of the cost that must be reduced. The motor truck is the development of this century to do the job. Why hamper it? Use it. It is the facility the railroads of this country need in meeting the transportation requirements of this generation.

Novel Plan for Checking Slopes

Because of the many and various materials encountered in excavation, and a limited width of right of way on the new Coast Highway of California through the Malibu Ranch, it has been necessary to employ numerous slope angles for cut banks, ranging from ⅜ to 1, to 1½ to 1. The arrangement for checking these slopes is described in California Highways.

Device for Checking Slopes.

In checking the various slopes, a 5-foot straight edge is employed with cleats attached at the proper angle. They are arranged in such a way that when a cleat is held horizontal as shown by an attached level, the straightedge is on the proper slope.

The straightedge is provided with six cleats on each side and can be used to measure the angle of twelve different slopes.

Convention of National Lime Association.—The 8th annual convention of the National Lime Association will be held at French Lick Springs, Indiana, on June 8-11. Advance reports indicate that the program will be devoted to more intensive activity in all departments. Only two outside speakers are included, and their addresses will probably be on distribution and on the more extensive use of lime in construction.

Wheel Bands for Fordsons

A protective band designed for use on Fordson wheels in operating over improved highways is illustrated. Owing to its construction this band is stated to not only protect the road surface but also gives a smooth running surface with ample face to assume good traction. The tread for the front wheels is 4 in.; for the rear 7 in. The bands are manufactured from heavy rolled steel sections, and are stated to be capable of withstanding heavy shocks and strains. They are rigidly clamped to the front and rear wheels, no alteration to the tractor being necessary. The attachment or removal is accomplished easily and quickly by means of a wrench. These bands are made by the Belmont Iron Works, 2215 Washington Ave., Philadelphia, Pa.

Fordson Tractor with Bel-Iron Wheel Bands Attached.

Relations Between the Contractor and the Engineer

Duties and Responsibilities of Engineer and Contractor Outlined in Paper Presented Jan. 14 Before American Road Builders Association

By C. M. BABCOCK
State Commissioner of Highways of Minnesota

The contact between the engineer (or architect) and the contractor should always be one of mutual confidence and cooperation.

These two, the engineer and the contractor, are jointly responsible for the utility, strength and beauty of the extensive amount of new construction which is annually completed; one because he is the designer, the other because he is the constructor. The two working together are the creators of structures of permanence, beauty and value. Their interests are therefore along the same lines and not divergent. For the greatest success of what is really their joint undertaking, is not mutual confidence and cooperation the best and absolutely the proper method?

Mutual confidence and cooperation can only be secured when both the engineer and the contractor recognize and accept their respective duties and responsibilities.

Duties and Responsibilities of the Engineer.—It is the duty of the engineer to make a sufficiently accurate and detailed survey of the conditions affecting the construction so that plans and specifications may be drawn to show clearly the extent and nature of the work to be performed.

Such accuracy is especially necessary where details are involved which the contractor cannot reasonably be expected to observe or investigate, such as, the depth of soft swamps over which fills are to be constructed, or the location of rock to which foundation footings are to be carried. Insufficient or inaccurate data on such items may cause more trouble and expense than a complete lack of information, by appearing to justify a method of procedure which would not otherwise have been adopted by the contractor without investigation. The more complete and definite plans and specifications, the fewer changes or extras required, and such completeness, beyond all question of doubt, reduces the ultimate or final cost to the owner, while at the same time the contractor is able to make more money at a lower price.

In the preparation of the plans and specifications therefore, a long step towards harmonious and satisfactory relations may be made if the engineer shows clearly and definitely in the plans and specifications the various details of the contemplated structure.

The Specifications.—Indefinite clauses and specifications such as "the work shall be done to the satisfaction of the engineer" should not be included as the contractor should find clearly shown in the plans and the specifications just what is required. The specifications should be so worded and the plans so clearly detailed as to have only one interpretation.

They should also be reasonable. Incorporating in the specifications clauses which are practically impossible of fulfillment with the thought that better work will be secured, is less apt to obtain this result than if the specifications provide for what it is reasonably possible to attain.

Drastic clauses inserted in the specifications with the idea of furnishing the engineer with requirements, which can be used to advantage in the case of irresponsible contractors and which on the other hand can be eased up for those contractors who are doing satisfactory work, are entirely wrong. Such drastic or unworkable clauses cause a cloud on the entire document as the responsible contractor feels that he is being placed in a position where an incompetent inspector or engineer might cause him serious trouble or expense.

In conjunction with the plans and specifications a fair and equitable standard contract should be used. Much progress has been made in the development of such contract by the Joint Conference of Standard Construction Contracts. The work of this conference will become effective only insofar as the spirit and principles contained therein are incorporated in the contract forms adopted by each engineer for the work under his charge.

In awarding the contract the engineer has the duty of selecting, insofar as governing conditions will permit, a contractor whose skill, integrity and responsibility qualify him to handle the work.

Determining Qualifications of Bidder.—Each contractor should be required to furnish data

necessary for the determination of his qualifications. Insofar as possible unqualified bidders should not be permitted to submit proposals on the work. Some means, such as qualification questionnaires, is needed for minimizing the operation of irresponsible contractors on public work and for encouraging the growth of more responsible concerns. Public officials, as a general rule, now have the authority to reject the bid of an irresponsible company, but in practical effect such authority can seldom be freely exercised.

After the award of the contract the supervision of the work falls to the duty of the engineer. While the engineer is employed by the owner, it is his duty to represent the rights and interest of both contractor and owner. This position is a very difficult one and unless the engineer is broadminded and fair it cannot be attained.

The engineer must be unprejudiced, intelligent and fairminded in the supervision of the work. Selfish, personal or opinionated decisions must be avoided. Any points in question must be decided on its merit in a broadminded way.

It is necessary therefore that the engineer should approach his work with a spirit of cooperation.

Facilitating Work of Contractor.—Much can be done by the engineer to facilitate the work of the contractor if this attitude is maintained. Such an attitude will enable the engineer to anticipate the requirements of the work so that actual delays are not only avoided but the contractor knows of such requirements sufficiently in advance to avoid last minute changes in plan of operation or organization.

The engineer should give thorough supervision to the work as it progresses. Slackness in correcting unsatisfactory work or methods at the beginning may cause dissatisfaction or effect hardship on the contractor. Such corrections can be made when the necessity is first apparent more easily and more fairly than after the conditions complained of have been permitted for some time.

On nearly every job of any magnitude the contractor raises the question as to whether or not certain work is to be performed under the contract unit prices. The engineer must be familiar with his plans and specifications in order to determine such questions. If the work done does not fall under the contract unit prices a price must be agreed upon or the work must be paid for on a cost-plus basis. This agreement should be reached and signed by the contractor and engineer so that the basis of payment is definitely understood and recorded at the time the work is done.

Extra Work.—The practice of paying for extra work by increasing the quantities of some contract item, such as increasing the classification or throwing the extra work into some large item, is not good business and should be avoided. Legitimate extra work should stand on its own merits and any engineer, who on account of slip-shod methods or fear of criticism by the owner, pays for it under other items and creates suspicion on the part of both the contractor and the owner. Written auhority should also be given where any change from the plan and specification is ordered or agreed upon.

While specifications ordinarily provide for shutting down the work under certain conditions, the engineer should make use of this requirement only as a last resort. Necessary corrections or changes should be anticipated so as to avoid interfering with the progress of the work.

All dealings should be with the contractor or his authorized representative. The engineer should not give orders or instructions to the contractor's men.

The engineer should see that partial and final estimates required by the contractor are furnished promptly. The partial estimates should include all items on which any payment is due. The omission of even small items raises a question in the contractor's mind as to his treatment on that portion of the work.

The duties of the engineer require that his decision shall be fair, prompt and responsible. Delayed decisions may be as unfortunate as wrong decisions. The decisions should be responsible in that the owner bears his share of the cost involved in such decisions as well as the contractor.

Duties and Responsibilities of the Contractor.—In the foregoing some of the duties and responsibilities of the engineer have been outlined. It must not be assumed, however, that the engineer is wholly responsible for producing and maintaining a satisfactory relation with the contractor. On the contrary, the contractor has many duties and responsibilities which he must recognize and assume in order to maintain the desired relation with the engineer.

The contractor should before submitting any bid, have a thorough knowledge of the specifications. This is being made reasonably easy by the adoption of standard specifications which are modified for each job only by special provisions which are attached to the proposal for the work.

The contractor should examine the site of the work and determine the various factors affecting its execution in the manner and within the time specified. The extent of this examination will be governed by the nature of the work involved.

The contractor who submits a proposal with-

out determining the force or equipment required for completion within the time specified, the source of the materials required and their acceptability, the hauling conditions likely to be encountered, the shipping facilities available or any other factor which is vital for a determination of the probable cost of the job and the time necessary for its completion, does by such negligence invite trouble with the engineer.

Having obtained complete information about the job, the contractor should submit an adequate and balanced bid. This would seem to be altruism the importance of which no contractor could overlook. Experienced engineers, however, realize that much of the trouble and much of the lack of cooperation between the contractor and the engineer originates from the fact that the contract has been taken at too low a price. Responsible contractors are all too frequently guilty of this mistake, and while they may not intend that this error shall affect the prosecution of the work, yet the personnel of the contractor's organization feel the responsibility of avoiding a loss, if possible. As a result cooperation with the engineer is less willingly given.

The evil of unbalanced bids is recognized by most specifications which stipulate this result as a basis for rejection of a bid. Frequently, however, the fault is disregarded at the time of the award with the expressed or subconscious hope that no such trouble will be caused thereby. The probability of trouble from such a cause is large, however, and a contractor who desires to cooperate in maintaining harmonious relations with the engineer will carefully avoid unbalancing his bid, even though such action might appear to be a shrewd move on his part.

Having obtained the award of the contract, the contractor must recognize many duties in connection with its execution in addition to the actual performance of the work.

The engineer must be kept sufficiently advised of his plans to that he may, first, inspect materials, before they are shipped where possible, or as they arrive at the work. Second, stake the work in advance of the arrival of the outfit. Third, check the plant and equipment as fast as it arrives, or as it is being installed.

As the work progresses any items for which there is no unit price should be called to the attention of the engineer. The responsibility for agreement on the basis of payment for extra items rests jointly upon the contractor and the engineer. Changes in plan or character of the work which in the mind of the contractor justify an adjustment of the contract prices, should also be brought to the attention of the engineer as soon as such changes become evident. The engineer may possibly assume that such changes involve no added unit cost. If the contractor considers the engineer wrong in this assumption, he is entitled to know the contractor's attitude at the time the work is being done.

The contractor has another opportunity for cooperation in the completion of the work as it progresses. Uncompleted odds and ends scattered over the work even though they are of a minor nature are a constant source of annoyance to the engineer. Frequently delay in their completion means added expense to the contractor as well as delaying the engineer in the final measurements which are necessary for the preparation of the final estimate.

The foregoing recital of the duties and responsibilities of the engineer and contractor, while incomplete, is sufficient to show that there is a joint responsibility for the maintenance of confidence and cooperation between the contractor and engineer. Broad-minded, fair, technically capable engineers are no less important than a contractor's organization made up of men who are willing to meet the engineers half-way and who take a pride in the quality of their work. Insofar as engineers and contractors each conform to this standard, will the ideal of mutual confidence and cooperation be realized.

Bibliography on Current Research

The National Research Council, 29 West 39th St., New York City, has published a bibliography on current reseach. The compilation was made by the Division of Engineering and Industrial Research and covers nearly 1500 references to articles on research appearing in scientific, engineering, technical and trade publications. In the bibliography the grouping of references is designed to serve a utilitarian purpose for the field of industry as a whole. In general, the arrangement and indexing follow the numerical reference numbers of the Engineering Societies' Library, which are based on the Dewey decimal system of filing. The major subdivisions are classified according to the fields of science, engineering, or related industrial groups. One major division, i. e., "Research—General" has been subdivided under the designations "Organization—Cooperative—Value of," etc., to provide a list of references from which material for addresses and papers on any particular phase of the general subject may be obtained. Descriptive articles concerning the design, organization, and operation of research laboratories have been segregated because of the limited sources from which correlated data on this subject can be procured.

Aesthetics in Engineering

The Need of Beauty in Engineering Discussed in Paper Presented Feb. 26 at the Short Course in Highway Engineering at the University of Illinois

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In the consideration of the subject, Aesthetics in Engineering and more particularly Aesthetics in Highway Engineering, the magnitude of the subject causes one to wonder where to begin and what can be said in a short time which might be inspiring and helpful. Men have spent their lives in trying to present this subject, many volumes have been written along this line; it is therefore rather presumptuous of the speaker to even suggest this subject for presentation in the time allotted on the program.

Aesthetics Defined.—What is aesthetics—The usual definition of this word is typified by the long haired individual, man or woman, thin, nervous, irritable, stoop shouldered, and with poor digestion, who works when he feels like it, usually from sunset to dawn, who likes to do the unusual, but is just plain queer. Let us have sympathy rather than censure for such individuals as they are fooling no one but themselves.

What is true aesthetics? As an adjective the word is defined as "pertaining to beanty, taste, refinement." As a noun it is "the philosophy of the beautiful; the principles underlying beauty."

Aesthetics in this paper is considered as "the principles underlying beauty." In order that we may understand the meaning of beauty or the beautiful, it should be remembered that prettiness and beauty are not synonomous and cannot be used to describe the same thing. A pretty thing is not always beautiful and something beautiful is much more than being pretty.

Again we turn to the definitions of words and it is found that Pretty is defined as "A form of beauty of delicate or inferior kind, delighting the fancy rather than the imagination. Pleasing the slighter elegancies of form, feature, arrangement, or design." But what is the meaning of Beautiful, "that which appeals or gratifies that sub-conscious self, sometimes referred to as the inner man. Certain properties of form resulting from the harmonious combination of diverse elements into a whole or into a unity." It is the beautiful in things that is being presented at this time.

The Practise of the Ancients and Today.—The common practise or the accepted theory today is widely different from that of the ages past. We look back at the results of the efforts of those people who created things centuries ago and who left us buildings, roads, bridges, and other structures which we admire and take for granted that such things should have been made beautiful but at the time they were built little did the builders know that they were not only to serve utilitarian purposes then but would stand as monuments for centuries to come. They built for their present needs just as we do now but they believed that everything which is to be seen should be beautiful and so built.

What of today? Do we think of anything except the structural and utilitarian purposes for which the structure is intended? Do we consider that any structure to be successful must combine a third element with that of strength and utility—that third part being beauty? Of two bridges designed for the same conditions, one a perfectly plain structure with no attempt at making it interesting to look upon but all the effort concentrated on making it safe, the other safe and strong but with some consideration given to making it interesting to look upon, which of the two will be chosen by three people out of five? Those choosing the interesting design may not know why they like it better but it makes an appeal to them that the other bridge does not.

The Present Day Division of Responsibility.—Today the aesthetic side, please keep in mind the definition of aesthetics used in this paper, of our everyday life has been left to the so-called artist or one who presumably is a specialist, one having creative ability and imagination and the question of strength and utility is left to the engineer and no thought is given to the fact that the three should enter every structure. This division of responsibility is a logical one under our present condition, dating back only a few years and caused by the development of new materials with which to work. In the days when brick, stone and mortar were the building materials, it was possible for one mind to know all there was to know in connection with the use and the limitations of these materials. With the introduction of steel, reinforced concrete and other new structural materials which made possible the complicate structures of today as represented by the high office building, the long transmis-

sion lines, the building of roads on all kinds of soil for all weather conditions and for ever increasing loads, it became impossible for one mind to know all of those materials and the age of specialization began.

This division of responsibility has been commonly accepted without thought or argument and we have today the structural steel specialist, the concrete specialist, the hydraulic specialist, the highway specialist. This is as it should be under our modern conditions but each of us has been content to settle in our narrow field and each has been indifferent to the others. The aesthetic individual has been content to design from his point of view and giving no thought to the structural elements having the attitude that the other fellow can worry about that and the engineer has designed his structure for utility and safety and has said "Why should I be concerned about how it looks."

The Age of Specialization.—This is the age of specialization and rightly so, not only in engineering and architecture but in all of the learned professions, such as medicine, dentistry, law, and all others. The field of knowledge and application is so large that life is too short for one mind to master all of the ramifications of any calling. When then? Will each specialist go about his own work ignoring or oblivious to all other requirements? Is the specialist in mental disorders forgetful that there is the nose specialist, the nerve specialist, and others?

While this is the age of specialization it is also the age of cooperation and the business of the world today needs cooperation. We are called upon to assume responsibilities along our chosen lines. We know what is needed along engineering lines but isn't it reasonable to believe that we are not doing our best or that we are not measuring up to our full opportunity unless we have called in specialists in other related lines, so that the final or complete development will have beauty—that beauty which has been defined as "certain properties of form resulting from the harmonious combination of diverse elements into a whole or into a unity."

The past 10 or 15 years has been the pendulum swing from the period where one master mind did everything in connection with a development to the other extreme where specialists worked independently and with complete oblivion to each other. In recent years those in charge are realizing more and more that there is more than each individual can know, resulting in this cooperation with others so that the result will be a unity, a harmonious whole.

While this highly specialized specialist is a victim of the times already referred to, it is an unnatural condition for in each of us there is some appreciation of beauty if it has not been purposely stifled.

It has been said that as a race we are slaves to tradition, that we are worshippers of precedent. If this is so, look at the background of the world's civilization and see what happened. Those monuments of engineering, skill and architectural beauty which have endured the elements of time and the criticisms of ages—who was responsible for them?

De Vinci, Michael Angelo, Wren.—The last of the fifteenth century there lived a great engineer, known in those days as a military engineer who was responsible for the work in irrigation, water control and harbor works, but this same master mind not only was an engineer of reputation but he painted "The Last Supper" and that much discussed picture "Mona Lisa." Leonardo De Vinci was a master engineer and he was a master painter.

Between 1475 and 1564 some of the greatest fortifications of Rome were built and during the same time a great building was built and stands today as a great example of the civilization of those days. Michael Angelo was not only responsible for the engineering work of his time but he designed the St. Peter's Church in Rome as well as painted several masterpieces.

Sir Christopher Wren, who lived from 1632-1723, designed St. Paul's Cathedral in London but planned the City of London after the fire and he was also an eminent engineer and a mathematician.

Some Ancient Structures.—One of the great achievements of the ages was the building of the Coliseum at Rome in 80 A. D. A great structure 500 ft. long, 300 ft. wide and 120 ft. high seating 87,000 people, a marvel in engineering skill and architectural interest. How many of the stadia built today will stand the test of time and the criticism of ages?

The Roman Viaduct at Nimes, claimed to be the grandest and most beautiful of all Roman works in foreign lands, was built by Agrippa, Governor of Nimes, under the direction of Emperor Augustus Caesar at the dawn of the Christian Era. Standing 161 ft. above the bed of the river, designed as an aqueduct but having provision for service as a regular bridge, it not only is an engineering achievement but a thing of beauty.

The Bridge of the Seine, the oldest of the Paris bridges, stands as a beautiful monument of medieval France. Started during the reign of Henry III in 1578 but delayed because of war and not completed until 1607, it stands today as a representative of engineering triumph and architectural beauty and a monument to the theme of this paper that engineering and art can be combined into a unity.

The Appian Way, 360 miles long, was built in 313 B. C. Not only was engineering skill required but the entire route was lined with arches, monuments and other structures which were a part of this great Roman Artery. This highway is interesting in another sense in that it is said that Julius Caesar, the Curator in 65 B. C., built the first and only monument to a road contractor.

What was it that made these old masters design and build structures, which in spite of the passage of time and the so-called refinement of taste, still stand as works of strength and beauty? After all what is this aesthetic treatment of structures but an adornment of the actual construction, or a clothing or covering of the frame or structural elements?

The simplest example of this is taken from the Egyptians. Their form of construction was known as the post and lintel type,—using the horizontal beam supported on columns or posts. While this was the construction required they decorated all this construction by painting or decorating. These people whom we think of as uncivilized were not content with strength and utility but they believed in beauty as well.

The Greeks in that age of architectural perfection merely decorated the structural features of the building. Taking the old form of pillow or bolster as used under the ends of two beams supported by a column, the Greeks merely decorated this bolster and made it pleasing in form and line while it served as a structural element.

Recent Structures Combining Utility and Beauty.—Today—what of today with its gigantic structures, long span bridges, wireless towers, tall office buildings, high dams, and railroad viaducts? What is being done to make these interesting in appearance as well as safe structurally? While the general impression has gone out that the engineer is not interested in the beautiful and the architect is not interested in the engineering, yet some of the structures built in this country during recent years and now building have this combination of the useful with the beautiful.

The Tunkhannock Viaduct of the D. L. & W. 2,375 ft. long and 240 ft. high is more than an engineering structure. Consider the offsets, the paneled piers and the moulded courses. This is a structure which makes an appeal to the public as well as being a great engineering achievement.

As I stood and looked at Hell Gate Bridge over the East River, New York with its great arch span of 977 ft., 140 ft. above the water, it made a great picture outlined against the sky. That master mind, Gustave Lindenthal, did not forget that this structure was to be seen as well as used and in the design of the piers, look at the thought and care that was given to make these attractive. As far as purpose is intended these piers could have been masses of plain concrete, unadorned, but look at the interesting treatment they were given.

The new bridge at Camden, N. J., not only required the efforts of a master bridge engineer but one of the greatest architectural designers of the country today was consulted with references to the artistic or aesthetic design of this greatest of all structures.

As we roll along over our magnificient highways, those in charge are to be commended on the interesting touches to the highway bridges. As far as purpose is intended, the railings and approaches could be plain, untreated surfaces, but some thought has been given to making these spots along the highways interesting. The brick panels, the moulded panels, the cap and base effect are attractive and add interest. These component parts of a railing have been made in proportion to height and width as they should be as the relation of the various heights of railings enter into the design just as the size of a man's hat is determined by the size of his head. As far as covering the head is concerned a hat three sizes too large would serve the purpose but the appearance demands a certain size.

Consider the highways with the vehicle as a unit. Have the automobile engineers been content to house the engine in a rough unattractive covering? Every detail is given care as to its purpose structurally and made beautiful, efficient in use, pleasing to the eye, and a joy to behold. A choice of two cars, each with the same engine but one unattractive in appearance, the other with beauty of design and pleasing outlines, which will you choose and which will the public choose?

The human race wears clothes primarily for protection. A gunny sack would serve this purpose but can you imagine your ever being willing to use this type of clothing—Never. We use color, we use the cut of the garment to enhance or beautify, but we don't stop there—we add certain adornments or decorations, entirely unnecessary as far as protection is concerned.

We demand these colorful garments used by the people who ride over these highways, with the beautiful designed cars that are seen by the hundreds of thousands on these great white ribbons—but are we doing our part to add interest and charm to the things that we create?

The master minds of ages past have felt the need of beauty in engineering, the master minds of the great engineering projects today have felt the need of adorning thir structures to make them more beautiful to look upon, are you and I doing our part in this great movement?

Smoothing Surface of Old Pavements

Experiences in Indiana with Bituminous Concrete Patches Described in a Paper Presented Jan. 20 at 12th Annual Road School, Purdue University

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Smoothing the surface of a pavement or macadam with bituminous concrete patches, is a very particular job. It is tedious and slow and unless the gang is well organized, lost motion will develop in many places. We know we are far from perfect in doing this work, but we feel that we are doing fairly well and hope our experiences will assist others in doing this work.

How to Obtain a Smooth Surface.—A rough surface is caused by irregularities, some spots being too high and others too low. The low ones can be filled, but the high ones cause more trouble. These high places can be removed by bush-hammering, but we believe the bush-hammering injures the pavement and shortens its life, so whenever possible we try to build approaches to these high spots which will not cause the car to bounce. Therefore, in smoothing the surface of a pavement we try to fill all the depressions, which cause the car to bounce, with a material which will soon harden and become as a part of the pavement.

The use of bituminous concrete in making these patches we find gives excellent results. This kind of concrete is made by mixing an aggregate with a bituminous binder. This mixture when first made is soft and pliable and can easily be spread into the depressions. The volatile matter in the bituminous material soon evaporates and with traffic compressing and compacting the mixture, it soon hardens and a patch is made which wears as good as the original surface.

These mixes are many and varied. In some the materials are mixed hot and in others they are mixed cold. The aggregate is also varied, different kinds of stone and gravel being used and various gradings of the aggregate called for, the bituminous binder being either a tar or an asphalt in some form. In doing work of this nature, we have found we get good results by confining ourselves to the use of a bituminous concrete made with a stone aggregate and a tar binder, and mixing both at normal temperature. We have used other variations and have obtained good results, but in this discussion we will touch only on the kind of mix.

Filling Depressions.—The work, while all done at the same time and by the same organization, is actually divided into two processes.

All depressions which require filling, and which are not over ½ in. in depth, are taken care of by a process which we call paint patching. In this class of work, the depressions after they are marked out, are painted with a hot tar and covered with stone screenings or pea gravel.

The depressions which are over ½ in. in depth, we fill with the bituminous concrete and cover with a seal coat. The depressions when they are not over 2 in. in depth are painted with hot tar, as in the first case, before the bituminous concrete is applied.

Survey of the Work.—After deciding to smooth a rough surface, the first thing to do is to determine, as near as possible, the amount of work to be done. The organization can then be planned and the materials and equipment assembled ready to begin work.

Driving and walking over the contemplated work and judging the roughness of the surface will give us some idea of what is to be done. By counting, checking, straight edging, etc., we can get an approximate idea of the number of bumps per mile. We can then prepare an approximate estimate of cost and a bill of material.

Estimating Work Required.—The conclusions we will give you under this subject are only rough approximations. They are stated for the purpose of giving the superintendent some data to go by in ordering his materials and are not to be used as a specification for doing this work.

From studies made of our work during the past season, we have arrived at the following:

A—The average patch will range in size from 3 sq. yds. to 5 sq. yds. Judgment in the field will have to decide which figure will best suit your piece of work.

B—1 sq. yd. of patch requires about

0.5 gal. tar for painting the depressions.
0.25 gal. tar for mixing the bituminous concrete.
0.25 gal. tar for seal coat.
0.33 cu. ft. of stone aggregate.
0.33 cu. ft. of screenings.

We believe that a road surface which is considered rough will have about 200 patches per mile; one which is very bad will average as high as 700 per mile. Figuring as estimate for repairing one mile of surface having about 200 patches per mile, and figuring 3 sq. yds.

as average size patch, we would have the following:

Patches per mile 200	
Square yards of patch 600	
Materials—	
Tar for painting patch	300 gal.
Tar for bituminous concrete	150 gal.
Tar for seal coat	150 gal.
Total tar	600 gal.
Stone aggregate for bituminous concrete	7½ cu. yd.
Stone screenings	7½ cu. yd.
Total stone	15 cu. yd.
Cost of materials—	
600 gal. tar	$100.00
15 cu. yd. aggregate or screenings	45.00
Miscellaneous (hauling, crayons, etc.) 10%	15.00
Labor, 90%	$160.00
	145.00
	$305.00

These figures were the average amounts of material used and turned in on the completion report for a ten mile project in Warrick County, the surface conditions being about the same as stipulated above.

Organization.—When you have a fair sized job ahead of you, it is best to so organize your gang that one man will keep busy at one or two operations continually. He can soon be taught to do these few operations quickly and easily and then he can go ahead without being watched. A gang organized on this basis should consist of the following:

The foreman of the gang has many duties. First of all he exercises a watchful attitude over the whole gang and keeps things in general going smoothly. He should watch the work of the marker and finisher very closely, as their work must be done right. He checks over the finished work carefully and corrects any bumps which have been left. He usually applies the screenings in making the paint patches and assists the tar man in applying tar when necessary, and moves the equipment along the road as progress is made. A good way for the foreman to keep check on results of his work is to look back over the work occasionally and notice whether cars going at a good rate of speed do any bouncing. Usually if a bump has been missed or a patch made too high, it can be detected in this way, or if he has a car available he can try it out himself, checking the uneven spots as he drives over the finished work.

The gang consists of the following:

Two men to mix the tar and stone (making the bituminous concrete) and deliver it to the patching gang.

One man to measure and mark out the patches. When he gets ahead with marking, he should drop back and assist the wheelbarrow man by loading the empty wheelbarrow for him.

One man to sweep surface where the patch is to be made. This man has some spare time which is taken up by helping the wheelbarrow man, usually by loading his empty wheelbarrow.

One man to tend tar kettle, handle and pour hot tar on depression.

One man to wheel and shovel the bituminous concrete on to the patch.

One man to spread the bituminous concrete and finish off the patch.

Equipment.—The equipment necessary for a gang of this size should consist of following:

One truck—2-ton capacity.
One truck—1-ton capacity.
One trailer—2-ton capacity.
One concrete mixer, 7 cu. ft. capacity.
Three wheelbarrows.
One tar heater, 200 gal. capacity.
One wire push broom.
One fibre push broom.
One stable broom.
One 14-ft. straight edge.
One 16-ft. straight edge.
Two 2-gal. tar pouring cans.
Four 10-qt. pails.
100 ft. common chalk line.
One box boiler makers crayon.
Two finishing shovels.
Various square point and round point and gravel scoops.

Description of Equipment.—The 2-ton truck is used to pull the trailer and tar kettle, and also to hold the screenings.

The 1-ton truck, is used to haul the bituminous concrete from mixing plant to the patching gang and also to haul the men to and from work.

The concrete mixer, must be a tilting drum type to give satisfactory results.

The straight edges are 2 in. x 6 in., one 14 ft. long and one 16 ft. long. They are best made from cypress, as they should be as light as possible. They are made two in. thick to prevent warping. The 14 ft. straight edge is for the finisher and the 16 ft. one is for the marker.

The tar pouring cans are made from galvanized sprinkling cans with the spout cut off about ½ in. from the body of the can, and the remaining part of the spout squeezed almost together, leaving an opening of about ¼ in. x 5 in. This kind of an opening tends to spread the tar very uniformly, and saves time spreading the tar.

The finishing shovel is a long handled shovel, and should be as light as possible, and have a square point 12 in. wide. A wider point is hard to handle and one more narrow slows down the speed of the finishing. This can be made by putting a long shovel handle in an old gravel scoop. Usually an old scoop will be worn and thin, which makes a light serviceable tool. The gravel scoop point can be heated and the point flattened out so that it will be level all along the bottom of the point.

The crayons used will run about 36 to the mile, so, often it will not be necessary to buy a whole box.

Materials.—The tars used are TP2, TM and TCM. The TP2 is used to paint the de-

pressions, to hold the screenings or bituminous concrete in place, also to be used in making the seal coat, unless there are a large number of square yds. to coat, when TM should be used. The TCM is used to mix with the aggregate to make the bituminous concrete.

The aggregate is usually of stone, although in gravel country pea gravel can be used in place of screenings. The sizes of aggregate used are as follows:

No. 6 screenings	½ in. to ¼ in.
No. 46	¾ in to ¼ in.
No. 3b	1 in. to ¼ in.
No. 34	1½ in to ¼ in.

We used as large size aggregate as possible in the bituminous concrete, which was to be applied in the depression. To do this, we made three different sizes of bituminous concrete. One size was made out of the No. 46 stone, one out of the No. 3b stone, and one size out of the No. 34 stone. In a depression of ½ in. to ¾ in. we applied the bituminous concrete or mix made of the No. 46 stone. In one having a depth of ¾ in. to 1¼ in. we applied a mix made of the No. 3b stone. In one having a depth of 1¼ in. to 2 in. we applied a mix made of the No. 34 stone.

In almost any depression a slightly larger stone size should be used than the measurement will call for. It is always advisable to use as near the proper sized aggregate to bring the surface up to normal as can be used. This, we think, would apply to any patch with a depth up to 4 to 5 in., using for a 4 in. depression a 3 or 4 in. stone if available.

Mixing Operation.—The mixing plant should be located near the road, and moved when necessary, so as to never be more than 2½ miles from the patching gang. At this plant should be kept the aggregates, the tars and the equipment for mixing. The equipment will include the light truck, the mixer, two 10 qt. pails, shovels and scoops.

Careful attention should be given to the arrangement and layout of the plant so that all lost motion be eliminated. One good way is to place each size of aggregate in a pile, arranging the piles in a row, so that the mixer can be moved along the row and the aggregate loaded direct from the pile into the loading hopper. The correct amount of aggregate is measured and placed in the hopper and leveled. A line is then painted around the inside, at the height of the leveled aggregate, which would show the loader how much stone to put into the hopper for each batch. The barrels of tar TCM should be handy to the mixer, but not in the way. They should be elevated above the ground high enough to place a pail under the bung. A standard molasses gate screwed into the bung saves time in handling the tar and also stops considerable waste.

The mixing is done by two men. One man loads the receiving hopper and brings the tar for the next batch. The other man dumps the mix onto a dumping platform, from which he then loads it into the light truck, ready to be hauled to the platching gang.

The batch must be allowed to mix thoroughly until each particle of the aggregate is completely coated with tar. The stone must be thoroughly dry and free from dust and dirt. Tar and damp stone will not mix, and bituminous concrete made with damp stone and put on the surface will disintegrate and ravel under traffic. A two or three days supply of stone is kept covered during the night and during rainy weather. In this way enough stone can be kept dry to keep the work going until the wet stone dries out. When a gang is laid up from work a couple of days, it disrupts the organization and it will take about half a day to get them lined out again when they do get started.

For 1 cu. yd. of aggregate, we use from 14 to 16 gals. of tar TCM, this amount being regulated by the size and cleanness of the stone. The temperature also has some bearing upon the amount used.

The two men mix and deliver to the patching gang about 1 cu. yd. of mix per hour. One batch will make about 5 cu. ft. of mix, the average time of mixing a batch being about 4 minutes, the balance of the hour being taken up in loading and delivering the mix to the patching gang. The average daily consumption of mix for a gang of this size will run from 7 to 8 cu. yds., so by the time the mixers produce this much mix, clean up and get ready for next day's run, their time is pretty well taken up.

Patching Operations.—On the way to work in the morning, the patching gang stops at the mixing plant and loads up with materials. The truck is filled with 2 cu. yds. of screenings, on top of which, 2 or 3 bbls. of tar TP2 is placed. The trailer is filled, with various amounts of the three sizes of bituminous concrete, depending upon the character of the surface to be patched that day.

Arrangements should be made by the foreman that one of the gang, the first thing in the mornings, goes to the tar kettle and starts a fire, so that the tar is ready for pouring when the gang arrives on the job.

Outlining the Depression.—This is done with a straight edge or line. It is a rather tedious task and should be done by some one who is a reliable workman. The depression is outlined with crayon, marking where the straight edge and surface begin to separate. The straight edge is laid parallel with the center line of the pavement about 1 ft. from one edge. Marks are drawn on the pavement show-

ing the outside the limits of the depression, the straight edge is then moved over about 18 in. or 2 ft. and the marking continued until the other side is reached or the patch runs out. The marker should also write the depth of the depression just outside the outline so the men applying the bituminous concrete will know what size to use.

The marker outlines all depressions of ¼ in. depth that are over 3 or 4 ft. in length. Depressions of this depth, but over 4 ft. long will not cause a car to bounce. Occasionally the marker will find a depression that the 16 ft. straight edge fails to cover. The foreman then assists him with a line, the line being held to the surface on each side of the depression, which is then outlined the same as when using a straight edge. On a place of this kind, the foreman must use his good judgment as the depression might be entirely too long to repair. If the depression is not over 1¼ in. deep, its length over 18 ft., and its approaches to the normal surface are gradual, it would not need filling.

Patching.—Following the marker, the sweeper thoroughly cleans the surface, using a wire push broom and a stable broom. The wire push broom is used to scratch up any foreign matter which may be stuck to the surface and the stable broom is used to sweep the dust off.

As soon as the depression is thoroughly cleaned, the tar pourer applies a coat of hot tar TP2 to its surface, except when the depth of the depression is over 2 in. deep. Where the depression is shallow (¼ in. or under) the application is made slightly heavier, as it is to be a part of the paint patch. The tar pourer should use two 2 gal. tar pouring cans instead of one 4 gal. can, as the two gal. cans are much easier to handle. After the tar is applied to the depression, he spreads it, using a fibre push broom. We first used a squeegee, but found that the fibre broom made a more uniform spread, the squeegee having a tendency to ridge the tar at its ends, which makes a ridge in the paint patch. This trouble, however, is more noticeable in repairing a rigid pavement than it is on a bituminous macadam.

Applying the Screenings (Paint Patch).—On the outside edge of the depression where the depth is under ¼ in., or over the whole depression if it does not exceed ½ in., the dry No. 6 screenings are applied. Judgment must be used in applying the tar and screenings in making these paint patches or feather edging the bituminous concrete patches, more tar and screening making a thicker mat, being applied at the deeper spots so that when finished the patch on its surface will be smooth and level with the surrounding surface. The foreman himself should apply these screenings because it is particular work.

Too many times we find the men applying too thick a coat of screenings. While this extra thickness of screenings is not harmful to the patch as the tar will only absorb so much, it is a waste of material. The dry screenings and hot tar are used for this purpose in preference to a bituminous mix, using this size aggregate, because it is more convenient to handle and finishes off much better than the bituminous mix on these thin patches.

Applying the Bituminous Concrete.—After the feather edge paint patch has been made on the outer edges of the depression, the bituminous concrete is applied. This is done by two men, the wheelbarrow man and the finisher. The wheelbarrow man brings the bituminous concrete to the depression in a wheelbarrow. Two wheelbarrows should be used, as the marker and sweeper will have time to load the empty wheelbarrow while the other is being emptied.

The wheelbarrow man must place the bituminous concrete where the finisher wants it, namely: close to the feather edging or on the edge of the bituminous concrete previously placed. It is then worked over into place toward the center by the finisher, using the finishing shovel, until a uniform surface is obtained.

The bituminous concrete in any one depression is usually of one size mix, but if the depth of the depression becomes deeper than 1¼ in. at any place, a mix made of 1½ in. aggregate should be used in these spots. In a case like this, the outer edges of the depression would be taken care of with the feather edge paint patch, the next portion from ¼ in. to 1¼ in. in depth, with the No. 3b mix, and the portion over 1¼ in. deep, with the No. 34 mix. It is not best to try and use the No. 34 mix to take care of the whole depression as it will contain too many large stones to give a satisfactory and even surface.

Finishing the Patch.—There are several things about finishing the patch and obtaining a smooth surface which should be mentioned. The foreman and finisher should insist that the bituminous concrete be not dumped into the center of the depression in a pile. See that it is applied by the shovelful just where the finisher wants it. This allows him to shovel it into place with his finishing shovel by pushing it off of the portion already placed, to the surface of the depression. This tends to spread the bituminous concrete more uniformly and eliminates any high or low places after the patch has compacted.

The finisher should always keep his finishing shovel in good shape, so that it will do good work. Often he will find it necessary to

remove the gummy substance which will collect on the point of his shovel. This can be done very easily by burning it off in the fire box of the tar kettle. In doing this he should be careful and not ruin his shovel by getting it too hot.

When spreading the bituminous concrete in cool weather, the finisher will find it pays to heat his shovel every few minutes, in order to get a good smooth finish to his patch. Usually the sun is hot and glaring when this work is being done. The finisher can relieve his eyes and also judge much better the smoothness of his patch if he will work with the sun to his back as much as possible. Looking down on the patch from this direction does not cause a glare and the uneven places are much more easily detected.

When the weather is very hot and the bituminous concrete has a tendency to be picked up by traffic, a small amount of clean stone (¾ in. to ¼ in.) hand scattered thinly over the fresh bituminous concrete will stop this. When the depth of the patch is under 1½ in. we do not tamp the bituminous concrete, but allow the traffic to do the compacting.

Until the finisher is thoroughly acquainted with his work and his eye has been trained to detect the slightest irregularity, he should always test his patch with a straight edge before leaving it. The foreman should not trust too much to the finisher's eye, but should satisfy himself completely that the patch is made satisfactorily.

Seal Coat.—If the work is smoothing a bituminous macadam surface prior to a surface treatment, the seal coat is not necessary. The surface treatment itself will supply the wearing coat and seal.

When the work has been smoothing a rigid pavement surface, the bituminous concrete portion of the patches must have all the open places closed or sealed. It is best not to do this until the traffic has thoroughly compacted the patch and any unevenness which may have developed has been corrected.

This seal coat is applied by painting the bituminous concrete with a hot tar TM, about 0.25 gal. to the square yard, and then coating the surface with our No. 6 screenings at the rate of about 0.25 cu. ft. per square yard. If the job is small, or you do not have any tar TM on hand, the tar TP2 will do.

Filling Deep Depressions.—At times we are called upon to fill a depression 6 in. or deeper. The depression should be filled with a stone aggregate up to within 2 in. of the normal surface. The size of this aggregate should be our No. 1 (4 in. to 2½ in.). After this stone has been carefully and uniformly spread and is smooth and level, hot tar TP6 or TP2 is applied at the rate of 1¾ gals. per square yard. Immediately after this tar application, there should be evenly spread over the surface, a covering material of No. 34 stone at the rate of 1 cu. yd. to 160 sq. yds. of surface. Upon this bottom course is then applied a 2 in. course of bituminous concrete made of No. 34 stone. After this has been thoroughly compacted, it should be given a seal coat.

If the job is small, it will not require as large a gang as we have outlined. Often not more than three men will be required. In a case where the force is reduced, it is better to have the man make the patches. The superintendent should study the situation, outline the work and assign the various duties as will best work out with the reduced force.

Tests of Concrete in Tension

In cooperation with and at the suggestion of the U. S. Bureau of Public Roads, a series of tests has been undertaken at the Engineering Experiment Station of the University of Maryland to develop more information as to the strength of concrete in tension compared with its strength in compression. Some details on these tests are given in the Jan. 1 Highway Research News by Dean A. N. Johnson.

The age of the specimens varies from a week or two to over 6 months. Two mixes were used, one for mortar, proportioned 1:2, and another of concrete, proportioned 1:2:3.

The tension specimens have a cylindrical center portion of the same size as the cylinders for compression tests, 4½ in. diameter and 9 in. high. The end of the tension specimens are truncated cones, with a gradual taper of approximately 1 in 24. The total length of the tension specimens is about 21 in.

A special device for holding the specimen was made that insures that the line of pull shall be coincident with the vertical axis of the specimen. This, it is believed, has been accomplished with as great accuracy as is practicable. Brass ends holding the specimen were made, an annular space between the specimens and the brass ends of approximately ⅜ in. being provided. This space, after the ends were accurately placed (which is readily accomplished by means of a split, hollow cylinder, clamped to the center of the specimen) is filled with melted rosin. The specimen ready for the testing machine, with brass ends attached, weighs approximately 95 lbs.

In addition to the ultimate strength of the concrete in tension, some observations are being made with the use of mirror extensometers to determine the elastic curves of the concrete in tension and compression. It is expected that full details as to manner of making the tests and results obtained will be presented this coming June at the annual meeting of the American Society for Testing Materials.

Concrete Pavement Designs

At the recent convention of the American Concrete Institute one of the most interesting papers to highway engineers dealt with the design of concrete pavements. It was prepared by L. W. Teller and J. T. Pauls, of the U. S. Bureau of Public Roads. One section, which discussed the economy of several typical slab designs, is cited in the Concrete Highway Magazine as follows:

The value of thickened edges has been thoroughly established, both in load carrying tests and by stress measurements. The corner formula, which assumes that the corner of a slab is an unsupported cantilever, has been found to check closely with the measured stresses in slabs. With this formula the maximum fibre stress is found on a diagonal across the corner of the slab. The section modulus, taken on this diagonal, forms an interesting basis for a comparison of designs that have been used or suggested for thickened edge pavements.

The section modulus, which is a measure of the strength of the slab, was figured for each design on diagonals 2, 3 and 4 ft. from the corner of the slab. The strength of each design was then compared on a percentage basis, using the Bates Type slab as 100, with the results shown in the table. As the quantity of concrete required per mile of pavement is given for each design it furnishes an interesting comparison of corner strength and cost per mile.

The section suggested by the American Association of State Highway Officials shows a very decided increase in strength for a moderate increase in cost. The center thickness of 6.3 in. is taken for this section because calculation indicates that when the longitudinal center joint is doweled, so that the two halves of the road act together to support the load, center thickness should be 7/10 the edge thickness.

CROSS - SECTIONS	SECTION MODULI 2'	%	3'	%	4'	%	CONCRETE PER MILE Cu.Yds.	%
9' 7" BATES TYPE	339	100	459	100	572	100	1858	100
9'	277	82	416	91	554	97	2053	110
9'	277	82	410	89	538	94	1906	103
9'	340	100	507	110	657	115	2154	116
4' 5' 9'	390	115	545	119	678	118	1935	103
A.A.S.H.O. 2' 3' 5' 9'	456	135	659	143	823	144	2112	114
(TRANSVERSE JOINT) PLAN SHOWING AREAS SECTION MODULI WERE COMPUTED EDGE OF SLAB CENTER LINE	STUDY OF STRENGTH AND ECONOMY OF SEVERAL CROSS SECTION DESIGNS U.S. BUREAU OF PUBLIC ROADS DIVISION OF TESTS							

Study of Strength and Economy of Several Cross Section Designs

New Bucket Loader

A new bucket loader has just been put on the market by the Barber-Greene Co., Aurora, Ill., as a companion to its Model 42 loader. The new loader has a rated capacity of 1 cu. yd. per minute in free flowing material. It weighs 9,500 lbs.

The main frame is built up of structural angles, channels and plates riveted together making it strong and rigid. The driving machinery is completely housed from dirt with removable cover plates in the housing for accessibility. The crawlers have self-cleaning links 10 in. wide, three-point suspension chilled rollers, and cast iron sprockets. The crawler frames are made of structural steel using 7 in. channels and plates riveted and welded, making them very rigid and strong and providing a take up for the crawler drive chain similar to that used on the 42-A Loader, i.e. by means of filler blocks inserted in steel

Barber-Greene Model 25 Bucket Loader.

pockets. The bearings for the driving axle are cast steel babbitted and riveted rigidly to the crawler frame preventing any misalignment of the shaft.

Each crawler is driven independently through a train of gears and chains taking power from the main jack shaft through 8 in. compression type of external band clutches. A Wagner auto-truck transmission is used with the machines driven by a gasoline engine, and a Midship-Type auto-truck transmission is used with electric motor drive. Borg and Beck master clutch type IOQL is used between the transmission and the engine.

Speeds are as follows: Low 30 ft. per minute, Second 60 ft. per minute, High 100 ft. per minute and reverse, out of the material, 26.5 ft. per minute. These vary slightly with electric motor on account of the different ratios in the transmission.

Either a General Electric motor 10 HP RPM to suit characteristics of available current or a Continental Red Seal gasoline power unit is furnished. The Continental Power Unit P-20 is a 4-cylinder gasoline engine 3⅜ in. bore, 4¼ in. stroke and rated 20 Brake HP at 1200 RPM. Speed is controlled through a Pierce governor. Lubrication is by means of combined force feed and splash system. The best known engine accessories are used, such as Zenith carburetor, Eisman high tension magneto with impulse starter, Perfection Air-Cleaner, and tractor-type radiator. The engine and parts are enclosed in a steel housing, weather proof with ventilating removable side panels. Alemite high-pressure lubricating system with Industrial fittings is used throughout.

The buckets are 18 in. by 8 in. made of malleable iron spaced 18 in. centers on two strands of No. 742 chain, running on the same size chilled head and foot sprocket as used on the 42-A Loader. A 30 in. patented revolving disc feed and scraper similar to that used on the 42-A Loader is provided for initial setting. Disc drive consists of steel bevel gears 2 to 1 ratio entirely enclosed in a cast steel housing, completely protecting them from dust and dirt.

The elevator boom is mounted on a curved track similar to the 42-A Loader. Power is transmitted from the main jack shaft through a single strand of Rex A.508 steel bushed roller chain to a safety sprocket with breaking bolt on the head shaft. The head shaft is 14 ft. 8⅜ in. from the ground approximately the same height as the 42-A Loader. The swivel spout of the 42-A Loader design is furnished. A strike-off hopper of 14 cu. ft. maximum capacity, or the standard overflow type, capacity of 12 cu. ft. is furnished.

Meeting of American Road Builders' Association

The regular annual meeting and "get-together" dinner of the American Road Builders' Association will be held at the Engineers' Club, 32 West 40th St., New York City, on Friday, May 14, 1926, at 7:00 p. m., daylight saving time.

At this meeting the officers and directors elected at the recent convention in Chicago will be installed; the reports of the board of directors and of the officers whose terms expire at that meeting will be received, and such other business transacted as may be found necessary. The officers and directors who take office at this meeting are as follows:

President, H. G. Shirley, Chairman, State Highway Commission, Richmond, Va.

Vice Presidents, W. R. Smith, President, Lane Construction Corp., Meriden, Conn.; S. T. Henry, Director, Pan-American Confederation for Highway Education, Spruce Pine, N. C.; S. F. Beatty, Vice President, Austin-Western Road Machinery Co., Chicago, Ill.; Samuel Hill, Honorary Life President, Washington State Good Roads Association, Seattle, Wash.

Treasurer, James H. MacDonald, Consulting Road and Paving Expert, New Haven, Conn.

Directors, R. Keith Compton, Director of Public Works, Richmond, Va.; W. H. Kershaw, Manager, Asphalt Sales Department, The Texas Co., New York City; William Ogden, Lakewood Engineering Co., Cleveland, O.; C. M. Pinckney, Chief Engineer, Borough of Manhattan, New York City; Frederic A. Reimer, Consulting Civil Engineer, East Orange, N. J.; Frank Terrace, President, Washington State Good Roads Association, Seattle, Wash.; C. M. Upham, State Highway Engineer, Raleigh, N. C.

The "Get-Together" Dinner will be held at 7:00 p. m., Daylight Saving time and will be informal.

140,000,000 sq. yd. of Asphalt Paving Laid in 1925.—An increase of nearly 150 per cent in the yardage of asphalt paving laid throughout the country is shown in the annual report of J. E. Pennybacker, secretary and general manager of The Asphalt Association. The asphalt yardage last year according to early reports was 140,000,000 sq. yd., compared to 55,700,000 sq. yd. in 1919, 73,800,000 sq. yd. in 1920, 71,200,000 in 1921, 89,900,000 in 1922, 108,000,000 in 1923 and 124,800,000 sq. yd. in 1924.

Concrete Tests in New Jersey

The New Jersey State Highway Department, in cooperation with the U. S. Bureau of Public Roads, has begun a series of concrete tests for the purpose of studying the relative concrete making properties of crushed stone and gravel used in concrete road construction in that state. The tests are being made in the State Highway Laboratory at Trenton, and involve the fabrication and testing of about 250 concrete beams 8 by 8 by 48 in. in size, as well as a large number of cylinders for compression tests.

The program calls for three series of tests. In the first series the workability of the concrete is to be kept constant, as nearly as possible, by means of the flow test, and the relative yield and strength of the concrete determined for each of several gradations both of crushed stone and gravel, using concrete proportions as given in the current New Jersey Standard Specifications. The object of this series is to determine the relative strength and yield of gravel concrete as compared with crushed stone concrete for several sizes and gradations of coarse aggregate.

In the second series an effort will be made to design concrete of a given strength by means of the water-cement ratio theory, for each type and gradation of coarse aggregate. The procedure to be followed in this series is essentially as follows. To each gradation, and type of coarse aggregate, fine aggregate will be added in the following ratios by volume, 33 to 67, 36 to 64 and 40 to 60. To each of the above combinations water and cement in fixed ratio, depending on the strength desired, will be added until the desired workability has been reached. The end point in each case will be determined by means of the flow test, supplemented by the judgment of experienced concrete operators. Concrete specimens will then be made up in the proportions as determined by the trial method referred to, and the comparative strength, which should be constant, the comparative yield, and the comparative absorption will be determined.

In the third series of tests specimens will be made in which the concrete mixture has been designed in accordance with the fineness modulus theory as given in "The Design and Control of Concrete Mixtures," a publication recently issued by the Portland Cement Association. The results obtained from this series will be used as a check against the results obtained in the second series.

Assuming a constant strength and a constant degree of workability, it is hoped to determine by means of these tests what grading of coarse aggregate and what proportions of fine to coarse will give the greatest yield of concrete for both crushed stone and gravel.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of Roads and Streets, published monthly at Chicago, Illinois, for April, 1926.

State of Illinois } ss.
County of Cook }.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared C. E. Bregenzer, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Roads and Streets and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:

Publisher, Engineering & Contracting Pub. Co., 221 E. 20th St., Chicago, Ill.; Editor, C. T. Murray, 221 E. 20th St., Chicago, Ill.; Managing Editor, H. P. Gillette, 221 E. 20th St., Chicago, Ill.; Business Manager, C. E. Bregenzer, 221 E. 20th St., Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Engineering & Contracting Pub. Co., 221 E. 20th St., Chicago, Ill.; H. P. Gillette, 221 E. 20th St., Chicago, Ill.; R. W. Hume, 221 E. 20th St., Chicago, Ill.; C. E. Bregenzer, 221 E. 20th St., Chicago, Ill.; Richard E. Brown, 625 Central Ave., St. Petersburg, Fla.; Commonwealth Title Ins. & Trust Co., Chestnut & Twelfth St., Philadelphia, Pa.; LaVerne Louer, Ambassador Hotel, Chicago, Ill.; Winifred Gillette, Edgewater Beach Hotel, Chicago, Ill.; Lewis S. Louer (Estate), Ambassador Hotel, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bond mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given, also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner, and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is ..... (This information is required from daily publications only.)

C. E. BREGENZER,
Business Manager.

Sworn to and subscribed before me this 30th day of March 1926.

(Seal) KITTIE C. WOULFE.

(My commission expires Feb. 9th, 1930.)